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# WORK PLAN FOR ZUNI PUEBLO WATERSHED



MC KINLEY COUNTY  
NEW MEXICO

JUNE 1975

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# ADDENDUM

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WATERSHED WORK PLAN

ZUNI PUEBLO WATERSHED

McKINLEY COUNTY  
NEW MEXICO



## CONTENTS

## INTRODUCTION

PART 1 - Discount rate comparison.

Application of  $.6\frac{1}{8}$  percent interest rate.

PART 2 - Display of impacts to national economic development, environmental quality, regional development, and social well-being accounts.

PART 3 - Display of the abbreviated environmental quality alternative plan.





## INTRODUCTION

This addendum is based on the Water Resources Council's Principles and Standards for resource planning.

The work plan for the Zuni Pueblo Watershed was developed using 1975 construction costs, current normalized agricultural prices, current non-agricultural prices, and 5-7/8 percent discount rate. The addendum for the project was developed using 6-1/8 percent discount rate.

Effects and impacts resulting from the selected work plan alternative are displayed under separate accounts for National Economic Development, Environmental Quality, Regional Development, and Social Well-Being.

The abbreviated environmental quality plan has been developed by an interdisciplinary team using information and data prepared and assembled during investigations and analyses for the watershed work plan. The development of the abbreviated environmental quality plan begins with a recognition of the watershed problems. Component needs to improve the environmental quality were developed and alternatives or options to solve the needs were determined.

These options were translated into specific plan elements. The estimated preliminary cost of the environmental plan is \$6,860,000. The expected environmental effects and impacts of the environmental quality plan are shown.



## PART I

This part of the addendum shows estimated project costs, benefits, and the benefit-cost ratio for the selected plan based on 6-1/8 percent interest rate for 100 years.

Current normalized prices and 1975 construction costs were used.

The average annual costs, average annual benefits, and the benefit-cost ratio for the selected plan at 6-1/8 percent interest are as follows:

1. Project Costs	\$243,210
2. Project Benefits Including Secondary Benefits	312,370
3. Benefit-Cost Ratio	1.3:1
4. Benefit-Cost Ratio Without Secondary Benefits	1.2:1



Components

Beneficial and Adverse Effects

A. Areas of Natural Beauty

Measures of Effects

1. Protection from flood damages will (a) promote beautification of the urban area in the Pueblo, (b) allow development of the irrigated cropland area into an expanse of green vegetation which will reduce dust storms, and (c) minimize sediment clouding of the water in the Zuni River and Tekapo Reservoir.
2. Rangeland treatment will stabilize gullies, revegetate the upper watershed, and promote a pleasing landscape to view.
3. Improved habitat will provide more frequent wildlife sightings.
4. Water retardation structure will create some dust and noise during construction and will present a raw scar until embankments are revegetated.
1. Dust from sediment deposition will be minimized.
2. Erosion on upper watershed will be reduced and gullies stabilized.
3. Runoff water will carry less sediment into the Zuni River.
4. Irrigation water management practices will make better use of less water.
5. Wind and water erosion will occur on disturbed areas until revegetation takes place.
1. Rangeland treatment practices will result in more cover and feed for wildlife, reduced streambank erosion, and better fish habitat in the Zuni River and Tekapo Reservoir.
2. Good irrigation practices will produce more crops and more feed for wildlife.
3. Water distribution for domestic animals will also provide water for wildlife.
4. During the period of revegetation wildlife habits and food supply will be disrupted.
1. Seven archeological sites will be enhanced by erosion control measures on rangeland.
2. Historic Pueblo of Zuni will aesthetically benefit from floodwater and sediment control.
3. Two archeological sites will be destroyed or disturbed by structure and nine will be subject to periodic inundation.
1. The dam and inundation area require 280 acres of rangeland that will be removed from full production.
2. Eleven archeological sites will be excavated and salvaged resulting in a net loss in total amount of archeological information remaining for future study and interpretation.

B. Quality Consideration of Water,  
Land, and Air Resources

C. Biological Resources and Selected  
Ecosystems

D. Historical, Archeological, and  
Geological Resources

E. Irreversible or Irrecoverable  
Commitments

SELECTED ALTERNATIVE  
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT  
Zuni Pueblo Watershed, New Mexico

<u>Components</u>		Measures of Effects 1/ (Dollars)	<u>Components</u>	Measures of Effects 1/ (Dollars)
<u>Beneficial effects:</u>			<u>Adverse effects:</u>	
1. The value to users of increased outputs of goods and services.			A. The value of resources required for a plan.	
1. Flood prevention . . . . .	232,790		1. Floodwater retarding and diversion structures	
2. Utilization of unemployed and underemployed labor resources	55,470		Project installation . . . . .	207,000
			Project administration . . . . .	20,610
			OM&R . . . . .	6,100
Total beneficial effects . . . . .	288,260		Total adverse effects . . . . .	233,710
			Net beneficial effects . . . . .	54,550

June 1975

1/ Average annual.



SELECTED ALTERNATIVE  
REGIONAL DEVELOPMENT ACCOUNT  
Zuni Pueblo Watershed, New Mexico

<u>Components</u>	<u>1/</u> Measures of Effects		<u>Components</u>		<u>1/</u> Measures of Effects	
	State of	Rest of			State of	Rest of
	N. Mex.	Nation			N. Mex.	Nation
	--- Dollars ---				--- Dollars ---	

Income:			Income:		
Beneficial effects:			Adverse effects:		
A. The value of increased output of goods and services to users residing in the region.			A. The value of resources contributed from within the region to achieve the outputs		
1. Flood prevention . . . . .			1. Floodwater retarding and diversion structures		
2. Utilization of unemployed & underemployed labor resources. .			Project installation . . . . .		
B. The value of output to users residing in the region from external economies			Project administration . . . . .		
1. Induced by and stemming from effects . . . . .			OM&R . . . . .		
Total beneficial effects . . . . .			Total adverse effects . . . . .		
			Net beneficial effects . . . . .		

June 1975

1/ Average Annual.

SELECTED ALTERNATIVE  
REGIONAL DEVELOPMENT ACCOUNT (Continued)  
Zuni Pueblo Watershed, New Mexico

<u>Components</u>	<u>Measure of Effects</u>	
	<u>State of NMex.</u>	<u>Rest of Nation</u>

Regional Economic Base and Stability

Beneficial effects:

The project will provide a 1 percent level of protection to 543 homes, 4 commercial businesses, two schools, one church, one mission, 16-unit teacherage, and the local jail in the Zuni Pueblo. 1,440 acres of irrigated land and 151 acres in the Zuni Pueblo will be protected. Interruption by floods of irrigation water will be eliminated. The project will help to bring back into production 834 acres. The project will create 9.2 semi-skilled jobs and 165 unskilled jobs during the installation period and 13.5 permanent semi-skilled jobs for one year on the Zuni Reservation, which has been classified by the Economic Development Administration as a Title V area because of severely depressed economic conditions.

Flood protection is an integral part of the success of many programs which are under way for the economic development and improvement of the Zuni Pueblo.

Adverse effects

--



SELECTED ALTERNATIVE  
REGIONAL DEVELOPMENT ACCOUNT (Continued)  
Zuni Pueblo Watershed, New Mexico

<u>Components</u>		<u>Measures of Effects</u> <u>State of</u> <u>N. Mex.</u> <u>Rest of</u> <u>Nation</u>		<u>Components</u>		<u>Measures of Effects</u> <u>State of</u> <u>N. Mex.</u> <u>Rest of</u> <u>Nation</u>	
<u>Employment:</u>				<u>Employment:</u>			
<u>Beneficial effects:</u>				<u>Adverse effects:</u>			
A. Increase in number and types of jobs				A. Decrease in number and types of jobs		0 0 0	
1. Employment for project construction	9.2 man-years of semi-skilled jobs over the 8-yr installation period	--		Total adverse effects		0	0
2. Employment for project OM&R	0.3 permanent semi-skilled jobs per yr.			Net beneficial effects		9.2 man-years of semi-skilled jobs over 8-yr installation period	
3. Employment in service and trade activities induced by and stemming from project operation	165 man-years of unskilled jobs over 8-year installation period					13.5 permanent semi-skilled jobs	
4. Agricultural employment	Utilization of 13.2 man-years of employment per year in agricultural production over and above present use					165 man-years of unskilled jobs over 8-year installation period	
Total beneficial effects							
						June 1975	

SELECTED ALTERNATIVE  
SOCIAL WELL-BEING ACCOUNT  
Zuni Pueblo Watershed, New Mexico

Components

Beneficial and adverse effects:

A. Real Income Distribution

Measures of Effects

1. Create 9.2 man-years of semi-skilled employment, 165 man-years of unskilled jobs and 13.5 permanent semiskilled jobs.
- 1/  
2. Create regional income benefit distribution of \$232,790 flood damage reduction benefits by income class as follows:

<u>Income Class</u> - - Dollars -	<u>Percentage of Adjusted Gross Income in Class</u>	<u>Percentage Benefits in Class</u>
Less than 3,000	25	40
3,000-10,000	51	53
More than 10,000	24	7

3. Local cost to be borne by region totals \$216,600. The percentage contributed by income classes was not shown because the land is owned by the Zuni Pueblo, and the project administration will be performed by the sponsor's staff. All other costs will be paid by federal funds. Therefore no cost distribution to income classes is warranted.

- 1/ The realization of these flood damage reduction benefits is considered to occur in Zuni Pueblo. Secondary benefits (\$25,360) will occur outside the city.

B. Life, health, and safety

1. Provide one percent level of flood protection to 543 homes, 4 businesses, and 16-unit teacherage, predominantly Indian, in a 151-acre urban area. Future threats of loss of life and displacements during floods will be eliminated. Eliminate pollution from animal and domestic wastes, outhouses and sewer backups. Prevention of flooding will reduce the need for immunizations during flood events.

## PART III

### ABBREVIATED ENVIRONMENTAL QUALITY PLAN

#### Zuni Pueblo Watershed, New Mexico

The goals of this environmental quality plan for the Zuni Pueblo Watershed are to preserve and enhance areas of natural beauty; maintain and improve the quality of the water, land and air resources; preserve and enhance the biological resources and ecosystem in the watershed; and study and protect the archeological resources in the area so that man can live in an esthetically and culturally pleasing environment.

The principal environmental quality problems in the watershed are deterioration of the land, plant, air, water, and archeological resources, and loss of property associated with intensive use and flooding.

The watershed lies within a setting characterized by rolling to steep topography bordered on the north by the steep cliffs of the white and red banded Zuni Sandstone Formation and on the south by the Zuni River. The Zuni River flows through the Pueblo of Zuni which is surrounded on the north and west sides by the Zuni Irrigation Unit and rangeland. The Irrigation Unit consists of about 2,400 acres of irrigable land.

The native vegetation includes pinon-juniper and woodland type species and grass species including sideoats grama, blue grama, threeawn, Indian ricegrass, western wheatgrass, sand dropseed, and alkali sacaton. The irrigable lands support basically pasture, hay, corn, garden, and vegetable crops.

The project area furnishes habitat for small rodents and weasels, skunks, and marsh hawks. Ground feeding songbirds, mourning doves, and scaled quail utilize the abundant weed seeds produced. Plant communities are simple ecosystems occurring on erodible soils, and can only support simple animal associations at low population levels. The range sites, except the breaks and escarpments, have deteriorated due to erosion resulting from past overgrazing by domestic livestock. Total vegetative production is much less than the potentials of the sites. Much of the irrigable land has been idle or only infrequently cropped, resulting in large stands of annual weed growth. The idle land is the result of damage from floods and a lack of an adequate supply of irrigation water.

Floodwater causes damage to the urban area of the Pueblo and surrounding irrigable lands. Erosion on the rangeland is higher under the present degraded vegetative cover than it would be under native vegetative conditions. Floodplain scour is occurring in the floodplains. The floodwaters interrupt irrigation during crop growth periods. Severe wind erosion and dust is occurring in the floodplain.

It is known that the Zuni Area of New Mexico is characterized by diverse and abundant archeological resources. Very little study has been made of the area, nor have protective measures been developed to protect the resources from agricultural activity and urban development.

Component needs for solving problems relating to specific environmental conditions are listed below:

1. Areas of natural beauty.
  - a. Create open spaces and green areas in the vicinity of the Pueblo of Zuni.
  - b. Landscape in the Pueblo of Zuni with trees, grasses, etc.
  - c. Reduce deterioration of beauty of watershed land.
2. Quality of water, land and air resources.
  - a. Protect the land resource base by reducing erosion.
  - b. Prevent damage to land, roads, streets, and property by flooding.
  - c. Reduce air pollution from dust in the Pueblo of Zuni.
  - d. Maintain and enhance productivity of land resource base.
3. Biological resources and ecosystem.
  - a. Restore the native grasses and vegetative patterns of the watershed on the land presently used for rangeland.
  - b. Preserve and enhance the habitat conditions for species of wildlife present in the watershed by:
    - (1) Providing more dependable flood sources.
    - (2) Reducing damage to habitat from flooding and erosion.
    - (3) Creating additional watering spots for wildlife.
4. Archeological resources.

Locate, investigate, and protect all important archeological sites within the watershed to prevent further accidental damage to these sites by agricultural activities or the destruction of these sites by artifact hunters.



The plan elements for environmental quality consist of a system of management practices, land treatment measures, and structural measures.

The elements and their estimated costs are as follows:

1. Apply land treatment measures for watershed protection and creation of food and cover for wildlife. Watershed lands will be managed for wildlife with a secondary use for grazing by livestock. Land treatment measures will consist of wildlife plantings, proper grazing use, range seeding, grade stabilization structures, debris basins, pasture plantings, wildlife and livestock watering devices, pasture management, and conservation cropping systems.

Cost: \$1,000,000

2. Install one multi-purpose structure to include storage capacity for sediment, floodwater retardation, and supplemental water supply.

Cost: \$4,500,000

3. Pave 10 miles of roads and streets.

Cost: \$ 200,000

4. Establish permanent grass or lawns in the Pueblo of Zuni.

Cost: \$ 550,000

5. Establish a park to include green area, trees, and open spaces.

Cost: \$ 150,000

6. Plant windbreak around Pueblo of Zuni.

Cost: \$ 10,000

7. Archeological investigations, salvaging, and site protection.

Cost: \$ 450,000

The total installation cost of the environmental quality plan is estimated to be \$6,860,000.

The environmental effects that would result from installation of the environmental plan are as follows:

1. Areas of natural beauty.

a. Cropland area will be converted to a green expanse.

- b. Oak Wash channel through cropland will be vegetated.
  - c. Gullies will be stabilized.
  - d. Viewing wildlife will be enhanced.
  - e. Cool season grasses will aid in greening landscapes early in the spring.
  - f. Homes can be beautified.
2. Quality of water, land and air resources.
- a. Air pollution from dust will be reduced, creating a healthful environment.
  - b. Prevent the deterioration of the land resource base by providing protection from erosion.
  - c. Maintain and enhance productivity of the land through agronomic and vegetative management practices.
  - d. Prevent destruction of agricultural and urban properties in floodplain of Oak Wash.
  - e. Provide a more dependable supply of irrigation water.
  - f. Increased fertilizer use will contribute to agricultural pollution.
  - g. Wind erosion will occur on structure sites until areas are revegetated.
3. Biological resources and ecosystems.
- a. Improve wildlife habitat in rangeland and irrigated lands.
  - b. Restore and stabilize plant ecosystems in the rangeland.
  - c. Reduced flooding and erosion will increase nutrients available to plants.
  - d. Provide a more adequate supply of water for livestock and wildlife.
  - e. Temporary interruption of wildlife habitat through installation and operation of planned elements.
  - f. Wildlife types and population will increase.

4. Archeological resources.

- a. Reduction of erosion in areas of archeological sites.
- b. Historic Pueblo of Zuni will be protected from floodwater and sediment.
- c. Provide for location, study, and preservation of important archeological sites to prevent the loss of information contained therein.

5. Irreversible and irretrievable commitments.

Require the use of land and commitment of labor, money, and materials to install, operate, and maintain the planned elements.





WATERSHED WORK PLAN AGREEMENT

between the

McKinley Natural Resource Conservation District

Pueblo of Zuni

Northwest New Mexico Resource Development Project Area

(hereinafter referred to as the Sponsoring Local Organizations)

State of New Mexico

and the

Soil Conservation Service  
United States Department of Agriculture  
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organizations for assistance in preparing a plan for works of improvement for the Zuni Pueblo Watershed, State of New Mexico, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service a mutually satisfactory plan for works of improvement for the Zuni Pueblo Watershed, State of New Mexico, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about eight years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire, with other than Public Law 566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated cost or value, \$8,600). The percentage of this cost to be borne by the Sponsoring Local Organizations and the Service listed above is as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organization (percent)</u>	<u>Service (percent)</u>	<u>Estimated Land Rights Cost (dollars)</u>
Floodwater retarding structure with associated outlet works and pipeline	100	0	8,600

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	<u>Sponsoring Local Organization (percent)</u>	<u>Service (percent)</u>	<u>Estimated Relocation Payment Costs (dollars)</u>
Relocation Payments	24	76	0 <sup>1/</sup>

---

<sup>1/</sup> Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will provide such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Construction Cost</u> (dollars)
<u>Floodwater Retarding Structure with Associated Outlet Works and Pipeline</u>	0	100	3,053,900

5. The percentage of engineering costs to be paid by the Sponsoring Local Organizations and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Engineering Cost</u> (dollars)
<u>Floodwater Retarding Structure with Associated Outlet Works and Pipeline</u>	0	100	244,000

6. The Sponsoring Local Organizations and the Service will each bear the costs of Project Administration which it incurs, estimated to be \$3,000 and \$346,600, respectively.
7. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their lands.
8. The Sponsoring Local Organizations will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.
9. The Sponsoring Local Organizations will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
10. The Sponsoring Local Organizations will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging



for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.
12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

A separate agreement will be entered into between the Service and the Pueblo of Zuni before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.
14. No member of, or delegate to Congress, or resident commissioners, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964, as amended, and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

McKinley Natural Resource  
Conservation District  
Local Organization

P. O. Box 447  
Gallup, NM 87301  
Address ZIP Code

By Clay Noble  
Title Vice Chairman  
Date 7-8-75

The signing of this agreement was authorized by a resolution of the  
governing body of the McKinley Natural Resource Conservation  
Local Organization  
District adopted at a meeting held on \_\_\_\_\_.

Chaucer Simpson  
Secretary, Local Organization  
Date 7-8-75

Drawer Y, Gallup, N.M. 87301  
Address ZIP Code

Pueblo of Zuni  
Local Organization

P. O. Box 338  
Zuni, NM 87327  
Address ZIP Code

By Dorson Zuni, Jr. Gov  
Title Acting Governor  
Date July 8, 1975

The signing of this agreement was authorized by a resolution of the  
governing body of the Pueblo of Zuni  
Local Organization  
adopted at a meeting held on July 8, 1975.

Francis Ponce  
Secretary, Local Organization  
Date July 8, 1975

**PUEBLO OF ZUNI**  
ZUNI, NEW MEXICO 87327  
Address ZIP Code

Northwest New Mexico  
Resource Development Project Area  
Local Organization  
Hubbard Building  
424 Mesa Verde Ave.  
Aztec, NM 87410  
Address ZIP Code

By Rodell Schmitt  
Title Chairman  
Date 6/30/75

The signing of this agreement was authorized by a resolution of the governing body of the Northwest New Mexico Resource Development Project Area Local Organization

adopted at a meeting held on 6-30-75.

Wilton F. Lechner  
Secretary, Local Organization

424 N. MESA VERDE  
AZTEC, N. M. 87410 ZIP Code

Date 6/30/75

By \_\_\_\_\_  
Local Organization Title \_\_\_\_\_  
Address ZIP Code Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the governing body of the \_\_\_\_\_ Local Organization

adopted at a meeting held on \_\_\_\_\_.

Secretary, Local Organization Address ZIP Code  
Date \_\_\_\_\_

Appropriate and careful consideration has been given to the environmental impact statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service  
United States Department of Agriculture

Approved by:

M. E. Shoup  
State Conservationist

July 11, 1975  
Date





WATERSHED WORK PLAN

ZUNI PUEBLO WATERSHED

Mc KINLEY COUNTY, NEW MEXICO

Prepared Under the Authority of the Watershed  
Protection and Flood Prevention Act (Public Law 566,  
83rd Congress; 68 Stat. 666), as amended

Prepared By:

Pueblo of Zuni  
(Sponsor)

McKinley Natural Resource Conservation District  
(Sponsor)

Northwest New Mexico Resource Development Project Area  
(Sponsor)

With Assistance By:

U.S. Department of Agriculture  
Soil Conservation Service

June 1975



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# WATERSHED WORK PLAN

## ZUNI PUEBLO WATERSHED

Mc KINLEY COUNTY, NEW MEXICO

June 1975

### S U M M A R Y O F P L A N

#### General Summary

The work plan for watershed protection and flood prevention for the Zuni Pueblo Watershed was prepared by the Pueblo of Zuni and McKinley Natural Resource Conservation District. Technical assistance in preparing the work plan was provided by the Soil Conservation Service, United States Department of Agriculture. The Bureau of Indian Affairs, United States Department of the Interior; Four Corners Regional Commission, Department of Commerce; the State of New Mexico and the Northwest New Mexico Resource Development Project Area also participated in preparation of the plan.

The watershed covers an area of about 20 square miles or 12,786 acres. Approximately 77.5 percent of the watershed is native rangeland, 15.8 percent is irrigated cropland, 3.0 percent is pastureland, and 3.7 percent is miscellaneous use. The area of miscellaneous use includes the 300 acres in the Pueblo of Zuni. Approximately 58 percent of the watershed area is within the Zuni Reservation. The remaining 42 percent is owned by the State of New Mexico.

Major problems are floodwater and sediment damages to urban property within the Pueblo of Zuni and to irrigated agricultural lands and crops. These damages occur from runoff resulting from high-intensity thunderstorms. Some of the more damaging floods occurred in 1922, 1924, 1946, 1958, 1963, 1964, 1965, 1967, 1969, and 1970.

Objectives of the sponsors are to develop a land treatment and management program for protection of the watershed lands and to provide flood protection to the Pueblo of Zuni and surrounding irrigated agricultural lands.

A combination of land treatment systems and structural measures was selected by the sponsors to achieve these objectives.



## Land Treatment

Land treatment and management systems will be installed by the Pueblo of Zuni on lands within the Zuni Reservation. Land treatment systems planned on the state lands will be installed by the operator. Costs will be borne by the Pueblo of Zuni for Reservation lands and by the operator for state lands.

Land treatment systems will include such measures as debris basin structures, grade stabilization structures, fencing, pasture planting, pasture management, range seeding, brush control, deferred grazing, and proper grazing use. The land treatment systems planned reflect a total cost of \$965,900. This is \$39,100 on state land and \$926,800 for the Zuni Reservation lands. It is planned for the land treatment program to be installed during an 8-year period.

## Structural Measures

Planned structural measures include one floodwater retarding structure and associated outlet works. The principal spillway discharge is to be conveyed to the Zuni River through a 36-inch diameter pipeline. The structural measures are planned to be installed in three years.

The estimated cost of installation for the structural measures is \$3,861,100. The PL-566 share is estimated to be \$3,644,500 and the share for other funds is \$216,600.

## Damages and Benefits

Average annual floodwater, sediment, and indirect damages to urban property in the Pueblo of Zuni, roads, streets, utilities, agricultural land, crops, farm improvements and irrigation facilities are estimated to be \$184,850. Installation of the project will eliminate damages to the irrigated lands and urban areas from all storms up to the 100-year frequency event.

The reduction of the flooding hazard will allow the Zuni Pueblo to more intensively farm 666 acres of farmland and to reestablish cultivation on an additional 834 acres. Benefits from this will be \$48,140.

Estimated secondary benefits which will accrue on an average annual basis from project installation and operation are \$25,360. Estimated redevelopment benefits are \$55,470.

## Environmental Impact

The installation of the planned projects will have the following environmental impacts.

a. Elimination of flooding and associated damages in the Pueblo of Zuni leading to:

- (1) Upgrading of homes and businesses, creating better urban environment.
- (2) Release of public and private monies previously needed for repairs and maintenance to other beneficial uses.
- (3) Reduction of health hazards such as vector breeding and water contamination.
- (4) Reduction of travel and service interruptions.

b. Reduction of flooding and associated damages occurring from a 100-year storm on 1,440 acres of prime irrigated land leading to:

- (1) Preservation of soil resources.
- (2) Better use and conservation of irrigation water.
- (3) Retention of maximum option for future use.

c. Improvement of vegetative cover on uplands leading to:

- (1) Reduction of soil erosion by five percent.
- (2) Increased quantity and quality of livestock forage.
- (3) Improved forage for wild herbivorous and seed-eating wildlife.

d. Increased production and improved composition of rangeland and shrubland vegetation on about 280 acres will create a more desirable habitat for wildlife species. Flooding will periodically interrupt wildlife and livestock use of this area.

e. Creation of about 175 man-years of employment during construction and the reduction of unemployment by about five percent.

f. Improvement of social and economic environment by increasing income and reducing costs of maintenance.

g. Temporary disruption of ecological functions on about 190 acres of rangeland and cropland.

h. Removal of some areas of brush in the upland which provides nesting and cover for birds and small animals.

- i. Commitment of 652 acres of rangeland and cropland to the construction, operation, and maintenance of the floodwater retarding structure.
- j. Creation of some noise and dust pollution during construction.
- k. Creation of a potential hazard from drowning for small animals when the detention pool fills rapidly.
- l. Increased use of fertilizers that will contribute to agricultural pollution.
- m. Commitment of 11 archeological sites to mitigating salvage and excavation will result in a net loss in total amount of archeological information remaining for future study and interpretation.

#### Benefit Cost Ratio

The estimated average annual benefits which will accrue to the planned structural measures are \$313,620. The estimated average annual costs of the structural measures are \$233,710. The benefit-cost ratio is 1.3:1.

#### Operation and Maintenance

Land treatment measures installed on the Zuni Reservation will be maintained by the Pueblo of Zuni. Land treatment measures installed on state lands will be maintained by the operator.

Structural measures will be operated and maintained by the local sponsors. The average annual cost of operation and maintenance of structural measures is \$6,100. The Pueblo of Zuni will bear the operation and maintenance costs.



W A T E R S H E D   R E S O U R C E S -  
E N V I R O N M E N T A L   S E T T I N G  
1/

Physical Data

The watershed consists of the drainage of Oak Wash and several small drainages that are ephemeral streams and tributary to the Zuni River. It is located in northwest New Mexico in the southwestern portion of McKinley County and encompasses an area of about 20 square miles or 12,786 acres. The land use in the watershed consists of 2,020 acres of irrigated cropland, 380 acres of irrigated pastureland, 9,910 acres of rangeland, 300 acres of urban and built-up lands within the Pueblo of Zuni, and 176 acres of miscellaneous land. At the present time, only about 666 acres of the area classified as irrigated lands are in production. The supply of irrigation water available will adequately irrigate only 1,500 acres.

The watershed is located in the lower Colorado Region and the Little Colorado Subregion as delineated by the Water Resources Council. This Region consists of (a) the Colorado River below the Lee Ferry Compact Point which is about one mile below the mouth of the Paria River; (b) Rios Yaqui, Magdalena, and Sonita and other lesser streams that ultimately discharge into the Gulf of California; and (c) the Animas Valley, Wilcox Playa, El Dorada Valley, and other smaller closed basins. The Subregion includes Apache and Navajo Counties in Arizona and McKinley County in New Mexico. This Subregion contains only a small percentage of the presently irrigated soils, although most of the dry farming practiced in the Lower Colorado Region is in this area. Elevations range from 4,000 feet above sea level to over 12,000 feet on Humphreys Peak, north of Flagstaff, Arizona. Land at the higher elevations is generally forested except for interspersed open areas. Most of the timber products from the Lower Colorado Region and much productive grazing is derived from this Subregion. In general, the soils are shallow in depth, often quite erodible, and are severely dissected in places.<sup>2/</sup> Accelerated erosion is occurring in some of the upland rangeland areas.

The Pueblo of Zuni straddles the Zuni River. The population of the watershed is basically within the Pueblo, with 60 percent of the population on the north side of the river. In the year 1539, when

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<sup>1/</sup> Note: All information and data, except as otherwise noted by reference to source, were collected during watershed planning investigations by the Soil Conservation Service, U.S. Department of Agriculture.

<sup>2/</sup> Lower Colorado Region - Comprehensive Framework Study - June 1971.

the Zunis were first contacted by non-Indians, they lived in six villages in the general area of the present reservation. By 1705, the Indians had abandoned permanent residences in all the villages except the present Zuni Pueblo. Presently, all except about 10 Indians on the reservation, live in the Pueblo of Zuni. In 1680, there were probably about 2,500 Zunis. The population figures since then are as follows:

<u>Year</u>	<u>Population</u>
1860	1,560
1910	1,660
1941	2,252
1951	2,922
1961	4,213
1970	4,952
1972	5,223

The Pueblo, originally built on high ground, has expanded on the floodplain of the Zuni River and Oak Wash as the population increased.

Gallup has a population of approximately 18,000. The Pueblo of Zuni lies 40 miles south of Gallup, which is the major trade center for the area. Another major trade center is Farmington, New Mexico, about 100 miles north of Gallup, which has a population of 27,000. U.S. Highways 666 and 550 connect Gallup with Farmington. State Highways 32 and 53 connect Gallup with the Pueblo of Zuni. Other trade centers for Zuni include Grants, New Mexico, 77 miles to the east via State Highway 53; and Albuquerque, New Mexico, 156 miles to the east via U.S. Highway 66 out of Gallup.

Major problems in the watershed are floodwater and sediment damages to urban property within the Pueblo of Zuni and to the adjacent irrigated agricultural lands and crops. The major problem areas include about 150 acres of the urban area of the Pueblo of Zuni and about 1,440 acres of the surrounding agricultural lands.

The watershed is located in the New Mexico and Arizona Plateau and Mesas Land Resource Area. In general, the soils in the lower portion of the watershed or the cropland area are deep, while the upland soils are shallow and rocky. Soil associations in the watershed are Navajo-Christianburg-San Mateo and Rockland-Travessilla-San Mateo. Approximately 614 acres (6 percent of the rangeland) that is classified as class VIII land is suited only for wildlife land or recreation. Of the rangeland portion, 3,427 acres (34 percent) is in loamy, range site; 1,947 acres (20 percent) is in sandy range site; 1,206 acres (12 percent) is in clayey range site; 783 acres (8 percent) is in shallow range site; 72 acres (1 percent) is in deep sand range site; and 2,485 acres (25 percent) is in breaks range site. Approximately 54 percent (5,357 acres) is in fair condition, 30 percent (2,976 acres) is in good condition, and 16 percent (1,587 acres) is in poor condition.



These rangelands support pinon-juniper woodland type plant species. The principal species include one-seeded juniper (*Juniperus monosperma*), gamble oak (*Quercus gambelii*), antelope bitterbrush (*Purshia tridentata*), fourwing saltbush (*Atriplex canescens*), greasewood (*Sarcobatus vermiculatus*), rubber rabbitbrush (*Chrysothamnus nauseosus*), broom snakeweed (*Gutierrezia sarothrae*), and big sagebrush (*Artemisia tridentata*). Sideoats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), muttongrass (*Poa fendleriana*), galleta (*Hilaria jamesii*), threeawn (*Aristida* spp.), western wheatgrass (*Agropyron smithii*), sand dropseed (*Sporobolus cryptandrus*), alkali sacaton (*Sporobolus airoides*), and Indian ricegrass (*Oryzopsis hymenoides*) make up the principal grass species.

The irrigated portion includes 2,400 acres of class I through class IV lands. These lands support basically pasture, hay, corn, garden, and vegetable crops. The soils are deep, with slopes of one to three percent.

The watershed is within the Colorado Plateau Region of the Basin and Range Physiographic Province and is underlain by red colored mudstone, fine grained sandstone, and clay shale of Jurassic and Triassic age. These rocks are all of terrestrial origin. Bare exposures of rock are common. The white and red banded Zuni Sandstone Formation rings the upper watershed in a series of steep cliffs.

The regional dip is southwest, resulting from uplift of the Zuni Mountains which lie 30 miles to the northeast. Locally, bedrock dips gently southwestward.

During early Tertiary time, contemporaneous with the Zuni uplift, much volcanic activity took place in this area. This activity, renewed during Pleistocene time, has resulted in numerous basalt flows on the present landscape. The flow nearest the watershed, originating to the northeast, terminated at Black Rock Reservoir two miles east of the proposed site.

The watershed lies in a semi-arid climatic zone with relatively mild winter temperatures. Mean annual temperature is 49.8 degrees F. and the average annual rainfall is 11.6 inches, as recorded at the Black Rock Station (Zuni Airport). Record temperatures are a high of 99 degrees F. and a low of -49 degrees F. The normal frost-free period is 160 days. Rainfall usually occurs during thunderstorms of high intensity and short duration, and may be associated with severe hail.

The watershed is characterized by high, dry, open country. Oak Wash originates in the steep topography of the Zuni Mountain foothills, and flows in a southerly direction to the Zuni River. In the upper portion of the watershed, Oak Wash has an unmodified, well-defined channel, typical of the arid areas of the southwest. Slopes in this portion of the watershed range from 25 to 55 percent. Approximately one mile north of Zuni Pueblo, Oak Wash crosses the Zuni Irrigation Canal and traverses Zuni Pueblo irrigated cropland. Channel capacity through this

reach is reduced by sediment, resulting in flood flows being forced out of bank and spreading out into an alluvial fan flow. This reach has no defined channel. The flows traverse the irrigated agricultural unit and then flow through the Pueblo of Zuni into the Zuni River. The slopes of the alluvial fan are relatively flat, approximately 0.75 percent. Mean sea level elevations range from 6,280 in the floodplain area along the Zuni River to 7,200 feet at the upper edge of the watershed.

There is no mineral production and no known potential for mineral production within the watershed.

Domestic and municipal water is supplied from wells. The quantity and quality are adequate for present and future use. There are no surface water supplies or potential within the watershed.

There are no water quality classifications established by the State of New Mexico for these drainages.

#### Economic Data

Approximately 8.4 square miles of the watershed is owned by the State of New Mexico and leased to a private operator. The operator incorporates this rangeland with his adjacent private lands as part of his cow-calf grazing operation.

The remaining portion of the watershed is owned by the Zuni Indian tribe and includes rangelands, irrigated cropland, and pastureland. Approximately 10 years ago, the rangeland portion was used entirely for sheep operations. The trend is to cattle operations. Today 50 percent sheep and 50 percent cattle operations exist in the area. Rangeland is considered to be worth \$35 to \$50 per acre.<sup>1/</sup>

The cropland and pastureland portion of the watershed is divided into about 240 operating tracts, which average approximately 10 acres in size. The crops grown are mostly alfalfa, corn, and garden vegetables. Average yields are 2 tons of alfalfa and 20 bushels of corn per acre. The farm land is irrigated from a storage reservoir and is considered to be divided into family type farms. About 1,440 acres are located in the floodplain of Oak Wash. The farm units are accessible to good roads and state highways. The land is valued at as much as \$500 per acre.

Ownership of Zuni Reservation land is vested in the Zuni Tribe. However, the household traditionally is the custodian of certain parcels of land, irrigated or grazing lands, or both, and the household receives the products of the land. The traditional farming areas and grazing areas are passed from generation to generation in the household.

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<sup>1/</sup> Land values furnished by Bureau of Indian Affairs, Appraisal Section.



*-Watershed Resources - Environmental Setting-*

The farm and ranch units are classified as low income producing units employing less than 1-1/2 man-years of labor. The Zunis seek additional income from other sources such as silversmithing. Low per capita personal income is reflected in the following table:

Per Capita Personal Income

<u>Year</u>	<u>Zuni Pueblo</u> \$	<u>New Mexico</u> \$	<u>United States</u> \$
1968	580	2,666	3,434
1970	906	3,044	3,910

1/ Zuni Pueblo Records, B.I.A.; unemployment rate in 1969 was 17 percent.

2/ U.S. Department of Commerce, Office of Business Economics.

The watershed is in the Northwest New Mexico Resource Development Project Area, which corresponds with New Mexico State Planning and Development District One. In addition, it is within the Four Corners Economic Development Region, designated under Title V of the Public Works and Economic Development Act of 1965. The following tabulation relates some of the socioeconomic characteristics of the subregion.1/

<u>County</u>	<u>P o p u l a t i o n</u>						<u>Income: % Less</u>	
	<u>Rural</u>	<u>Urban</u>	<u>Minority Races</u>			<u>Other</u>	<u>per Capita</u>	<u>than Poverty</u>
			<u>Spanish</u>	<u>Indian</u>	<u>Negro</u>			
Apache, AZ	:32,298:	-	: 2,379	:23,994:	416	: 154	: 1,282:	52.7
Navajo, AZ	:34,890:	12,825:	5,357	:23,023:	916	: 351	: 1,687:	39.2
McKinley, NM	:24,654:	18,554:	8,626	:26,507:	410	: 294	: 1,717:	40.1
	:	:	:	:	:	:	:	:

1/ Western U.S. Water Plan Socioeconomic Characteristics, January 1973.

The following tabulations relate the socioeconomic data for McKinley County:

INDUSTRY OF EMPLOYED PERSONS <sup>1/</sup>  
TOTAL EMPLOYED, 16 YEARS OLD AND OVER

Industry	No.	%
Agriculture, Forestry, Fisheries	150	1
Mining	319	3
Construction	670	6
Manufacturing	1,049	9
Railroads and Railway Express Service	512	5
Trucking Service and Warehousing	96	1
Other Transportation	77	1
Communications	124	1
Utilities and Sanitary Services	174	2
Wholesale Trade	303	3
Food, Bakery, and Dairy Stores	240	2
Eating and Drinking Places	465	4
General Merchandise Retailing	256	2
Motor Vehicle Retailing and Service Stations	478	4
Other Retail Trade	806	7
Banking and Credit Agencies	119	1
Insurance, Real Estate, and Other Finance	91	1
Business and Repair Services	220	2
Private Households	93	1
Other Personal Services	431	4

<sup>1/</sup> General Social and Economic Characteristics, New Mexico, 1970 Census of Population, U.S. Department of Commerce, Table 123.



## Fish and Wildlife Resources

The project area is composed of several different plant communities that provide distinct terrestrial environments that are capable of supporting associations of wildlife species. There are no permanent aquatic or wetland environments in the watershed that support stable populations of wildlife species.

The Zuni Irrigation Unit, an area of 3.75 square miles (18.8 percent of the project area), is within the project area. It comprises a block of very diversified cropland and pastureland associated habitats. Much of the irrigable land has been idle or only infrequently cropped, resulting in large stands of annual weed growth. Intermingled fields of corn, vegetable crops, and alfalfa occur throughout the unit.

Considered as a composite, the unit furnishes excellent habitat for small rodents and weasels (*Mustela Frenata*), skunks (*Mephitis mephitis*), and marsh hawks (*Circus cyaneus*), which feed upon them. Ground feeding songbirds, mourning doves (*Zenaidura macroura*), and scaled quail (*Callipepla squamata*) utilize the abundant weed seeds that are produced.

The rangeland portion of the watershed, which amounts to 15.5 square miles (77.5 percent of the project area), includes a number of different habitat types, as reflected by the six major range sites, as well as past land uses and treatments.

All range sites, excepting the breaks and escarpments, have deteriorated due to erosion resulting from past overgrazing by domestic livestock. Total vegetative production, and particularly that of preferred browse species, is much less than the potentials of the sites. Plant communities are simple ecosystems occurring on fragile soils, and can only support simple animal associations at low population levels.

A typical wild animal community now being supported on the rangeland habitats will include the collard lizard (*Crotaphytus collaris*), prairie rattlesnake (*Crotalus viridis*), Ord kangaroo rat (*Dipodomys ordi*), pocket mouse (*Perognathus* spp.), horned lark (*Eremophila alpestris*), raven (*Corvus corax*), badger (*Taxidea taxus*), and coyote (*Canis latrans*).

The range habitats furnish only extremely marginal conditions for scaled quail, with populations estimated to be 0 to 10 birds per section. By comparison, average statewide habitats will support 50 to 60 birds per section, and good habitats will support 150 to 200 birds per section in good years.<sup>1/</sup>

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<sup>1/</sup> Data furnished by N.M. Department of Game and Fish.

The range habitats within the watershed area do not presently support resident mule deer (*Odocoileus hemionus*). Only 8 percent of the watershed area currently provides any significant density of preferred browse species that are needed for mule deer habitat. Bitterbrush, while occurring in densities of 400 to 3,000 plants per acre, exhibits indications of past overuse with 40 percent of the plants in a decadent condition. Current utilization of bitterbrush is 30 to 40 percent of new plant growth. Mule deer occupy adjoining ranges outside of the immediate watershed, and are known to move through this watershed.

Data published by the New Mexico Department of Game and Fish<sup>1/</sup> describes Game Management Unit 29 (of which the Zuni Reservation comprises 83 percent of the 864 square mile area in the unit) as consisting of only 30 percent suitable mule deer habitat. Annual habitat condition evaluations, including population estimates, are not conducted by the Department on Unit 29 because "it is generally only marginal deer habitat . . . heavily overused by sheep . . . and because of its relative unimportance in deer management".

Hunting on the Zuni Reservation is managed by the Zuni Game and Fish Department. In 1973 there were about 575 deer hunting permits sold, with an estimated 5 percent hunter success reported.<sup>2/</sup> By tradition, the Zuni people do not engage in sport hunting for quail, mourning dove, or waterfowl species.

Sport fishing on the Zuni Reservation is provided in six multiple-purpose reservoirs, none of which are in the watershed. The Zuni Game and Fish Department issues daily or seasonal permits. Management of the fisheries, including stocking, is the responsibility of the U. S. Fish and Wildlife Service, USDI.

The watershed area does not contain resident or breeding populations of threatened wildlife species as described in the 1973 Edition - "Threatened Wildlife of the United States". The Southern bald eagle and the peregrine falcon are known to seasonally frequent this region of the state, and it is expected that individual birds may fly over or hunt in the watershed.

### Recreation

There are no developed recreational facilities in the watershed area. The sponsors have not expressed interest in making recreation a project objective. The watershed area has no potential for the development of water-based recreation.

The Zuni Pueblo has carried out a long-term program of providing outdoor recreation opportunities for both the tribe and general

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<sup>1/</sup> Game Surveys, Federal Project W-93-R-5 to 15.

<sup>2/</sup> Personal communication.



public. Overnight camping areas have been provided in addition to several picnic units. Permits are sold for the hunting of mule deer. Tourism and tourist accommodations are continuing to receive emphasis, including urban parks, sports areas, and playgrounds.<sup>1/</sup>

#### Archeological and Historical Values and Unique Scenic Areas<sup>2/</sup>

The Zuni area of New Mexico is characterized by diverse and abundant archeological and historical resources which represent different patterns of adaptation ranging in age from several thousand years B.C. until the time of Spanish entry into the southwest.

The earliest manifestations of human activity in this area of New Mexico include evidence of a relatively long period of big game hunting as well as hunting and gathering adaptations. Following introduction of domesticated plants and development of sedentary life, further regional specialization occurred. Two somewhat different Puebloan manifestations eventually evolved in northwestern and west central New Mexico. The historic Zuni culture appears to have developed out of a Puerco-Chacoan base in the early Pueblo periods, and was more closely related to the Anasazi Pueblo development in the north. Later Zuni culture, however, appears to have been the product of influence from extensions of the Mogollon Pueblos to the south of Zuni.

While the northwestern area of New Mexico has been the focus of numerous archeological investigations, much of the work has centered around the more spectacular sites dating to the Puebloan periods. Less work has been done on earlier Basketmaker periods. Little is known regarding the nature of the relationships between the Zuni area itself and the other major developments in the southwest.

In order to provide factual information regarding the presence and significance of archeological resources in the area of the Oak Wash Dam Project, the Arizona State Museum, under contract with the National Park Service (Arizona Archeological Center), conducted an archeological survey of the project area during the months of July and August 1972. Three reports which discuss the results of this investigation are: (1) "Archeological Clearance Investigations, Bureau of Indian Affairs, Pueblo of Zuni, Zuni Indian Reservation, McKinley County, New Mexico--Final Report for Oak Wash Dam Project" by Dana Isham; (2) "Archeological Survey of the Proposed Right-of-Way for the Oak Wash Dam-Zuni River Pipeline" by Ric Windmiller; and (3) "Impact of the Oak Wash Dam Project on Archeological Sites near Zuni, New Mexico" by Ric Windmiller. These are available from the National Park Service.

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<sup>1/</sup> Zuni Comprehensive Development Plan, 1969.

<sup>2/</sup> Information furnished by National Park Service and Arizona State Museum, University of Arizona, Tucson, Arizona.

The survey revealed the presence of 19 archeological sites in the project area that range in cultural affiliation from Late Basket-maker to protohistoric. Functionally, these sites appear to represent a number of diverse activity areas ranging from seasonal occupation sites to sedentary pithouse villages. The sites also constitute a set of cultural and temporal manifestations never examined in detail in the Zuni area. Specific site descriptions are detailed in the report by Isham. Windmiller's report includes tables that summarize the general settlement types and time periods represented by the sites in the project area. Windmiller's report also includes a map showing site locations.

The National Register of Historic Places lists only two properties as National Register sites in McKinley County. Neither are in the vicinity of Zuni nor the Oak Wash Dam Project. While the possibility exists that Zuni Pueblo may eventually be nominated to the National Register, such action has not yet been taken.

#### Soil, Water, and Plant Management Status

The project area is furnished technical assistance through the Soil Conservation Service field office at Gallup, New Mexico, in cooperation with the McKinley Natural Resource Conservation District. There are about 240 operating units covering 100 percent of the watershed area under cooperative agreement with the McKinley NRCD. Conservation plans have been developed for the watershed area.

Proper grazing use has been applied on a portion of the watershed. In addition, some brush management has been carried out on areas of the watershed and a few small erosion control structures have been installed. Some labor and capital are being employed for crop production in the floodplain that covers a large portion of the irrigated agricultural lands. Presently, labor and capital are used to a small degree because most of the cropland in the floodplain is idle and not being farmed.

The constantly changing course of floodwater and sediment depositions from successive flood events and an inadequate supply of irrigation water has discouraged the Zuni farmers to the point that most of the irrigated land is idle. As recently as 1938, all the idle land in the northwest portion of the Zuni irrigation unit was in alfalfa.



## WATER AND RELATED LAND RESOURCE PROBLEMS

### Land Treatment

The watershed lands, as a whole, are very fragile and highly erodible, and much of the area is steeply sloping. Lack of adequate vegetation due to overuse by livestock and drought increases the area's susceptibility to erosion.

Sheet erosion and much gully erosion occur over a portion of the watershed area that needs erosion control in the form of small rock, log, net wire or other types of gully plugs. These need to be installed in most of the small water courses to reduce the velocity of the water. Debris basins or small earth structures with a pipe used as a principal spillway are needed in several of the main drainages.

Sagebrush composes about 45 percent of the vegetation over areas of the watershed. Sagebrush is not desirable in the present composition now found in the plant community and needs to be managed. This area would respond faster if reseeded to alkali sacaton and western wheatgrass in a mixture and deferred from grazing for a minimum of two years.

In other areas of the watershed, pinon and juniper compose approximately 10 to 15 percent of the ground cover. Some of these areas were chained in 1966 but the pinon and juniper are resprouting and need follow-up management and treatment. A large percentage of the resprouting is occurring from trees that were not completely uprooted in the first chaining operation. Brush management is needed on other pinon and juniper areas. Some of the areas will also need to be reseeded. More useful vegetation, providing multi-purpose benefits, can be established and maintained on these sites.

### Floodwater Damage

Flooding, sediment deposition, and erosion are the major problems in the watershed. Oak Wash crosses the Zuni Irrigation Canal approximately one mile north of the Pueblo. The flows traverse the agricultural alluvial fan below the canal. The slopes of the alluvial fan are very flat which creates sediment deposition problems. The flows fan out in this area, resulting in flood-flows spreading over a large portion of the urban area of the Zuni Pueblo and the surrounding irrigated farm land.

Floods from high-intensity thunderstorms occur frequently. Damages occur almost every year as the fan-flow must traverse the agriculture fan and the urban fan before entering the Zuni River. Accounts of past floods obtained from local sources indicate that some of the



more damaging floods occurred in 1922, 1924, 1946, 1958, 1963, 1964, 1965, 1967, 1969, and 1970. The storms occur mostly as high-intensity, short-duration summer thunderstorms. The resulting runoff is characterized by relatively large peaks with short-duration flows. Sediment transport is very high and may contribute as much as 50 percent to the peak discharge and volume of runoff. Due to the meandering of the overland fan-flow of floodwater, it is impossible to predict where flooding will occur from individual storms.

Flooding causes structural damage to homes and businesses and their contents in the Pueblo of Zuni. Water ponding from these floods creates health hazards from disease-carrying flies and mosquitoes, water stagnation, and sewage pollution. With the expanding population and limited high ground, new housing has moved onto the floodplain. The movement to the floodplain has increased the potential for flood damage. Floods from a storm having a one percent chance of occurrence will flood 151 acres in the Pueblo of Zuni, resulting in damages to 543 homes and to commercial establishments and utilities. Annual flood damage to homes will be \$131,240. Annual damages to commercial establishments and utilities contribute another \$11,040.

Floods damage irrigation delivery canals interrupting irrigation water delivery. These frequent floods interfere with the delivery of irrigation water from the main canal. If the canal is broken or silted up, the irrigation water must be turned off at Black Rock Reservoir, three miles above the intersection of the canal and Oak Wash. Even a small break may cause the irrigation water to be turned off for a week until the area dries out and equipment can be moved in. This interruption of irrigation water begins with a storm having a 10 percent chance of occurrence and affects about 666 acres of cropland. Repair of flood damage to the canal amounted to \$960 in 1969 and \$4,100 in 1970. Flood damage to the road along the canal averages \$500 per year.

About 1,440 acres of irrigated lands are subject to flooding. Based on present conditions, a storm having a one percent chance of occurrence could flood 782 acres of the irrigated land. The crops grown are alfalfa, corn, and garden vegetables. The estimated average annual floodwater damages to agriculture amounts to \$3,860. The estimated damages from a one percent chance storm (100-year frequency) is \$520,000.

Flood damage and sediment damage from the 1970 storm is typical of damages incurred in the watershed. Official documented records of past floods are not available. Because of the lack of historical flood and precipitation data, hydrologic and meteorologic data was synthesized. This storm appears to have been approximately a 50-year event, and inundated a large area of the Pueblo of Zuni and about 400 acres of the surrounding agricultural lands. Based on synthesized data, it deposited approximately 390 acre-feet of sediment in the floodplain.

The peak flow was approximately 6,000 cubic feet per second over the floodplain, resulting in depths of about 2.0 feet. Flooding from the Zuni River occurs along the floodplain adjacent to the river. Figure 5 shows the floodplain of the Zuni River and its relation to the project area. About 70 acres of the Zuni River floodplain is common with the Oak Wash floodplain. Storms resulting in damage from Oak Wash usually would be a separate storm from that causing damage from the Zuni River.

#### Erosion Damage

Accelerated erosion is occurring in the uplands within the watershed. Erosion rates are high. The average annual gross erosion is estimated to be 8.8 acre-feet per square mile. Four percent of the watershed was found to be severely gullied, 34 percent suffers slight to moderate erosion, 33 percent suffers severe erosion, and 29 percent suffers geologic or minor erosion on shallow, rocky soils or bare rock. It is estimated that gully and streambank erosion is the source of 60 percent of the damaging sediment. The remaining 40 percent is from sheet and rill erosion. Minor scour damage is occurring on fields near the channel where it flows onto the irrigated lands. Scour damage was not evaluated because it was not considered significant.

#### Sediment Damage

Sediment from Oak Wash is deposited in the irrigation canal, causing a maintenance problem. Accumulations of sediment fill the canal and cause the irrigation water and floodwater to break the canal banks.

Sediment spread over the cropland does not cause a long-term loss of productivity to the land. Besides the crop losses and damage to irrigation ditches, the heavy deposition of silt and fine sand on 421 acres disrupts irrigation grades and irrigation water management. The frequency of crop loss has discouraged the Zuni farmers. Fertilizers are not used for maintaining productivity.

Severe sediment damage occurs in the urban areas where sediment is deposited in homes, businesses, and on equipment. The sediment fines which settle in the Pueblo are later stirred by wind and traffic, causing severe dust conditions. The high rate of respiratory ailments among the Zuni Indians is significant.

Sediment from the watershed passes into the Zuni River floodplain and Tekapo Reservoir that is about six miles downstream from the Zuni Pueblo. Tekapo Reservoir provides water for irrigation and wildlife habitat. It is estimated that the watershed contributes an average of 43.5 acre-feet of damaging sediment to the Zuni River floodplain and croplands each year.

The average annual sediment damage for the future, without project conditions, is estimated to be \$15,440.



### Irrigation and Drainage

The irrigated lands are irrigated from a storage reservoir (Black Rock Reservoir). Presently, storage in the reservoir has been reduced by accumulation of sediment, and water is available to irrigate only 1,500 acres. It is estimated that approximately 95 percent of the irrigable land will be irrigated in the next 10 years. The additional water needed for irrigation will be made available through enlargement of Black Rock Reservoir. The existing irrigation systems are not adequate to provide good irrigation water management. Technicians from the Bureau of Indian Affairs are working with the people to plan for needed improvement in irrigation systems. Presently, 666 acres of the cropland are being irrigated.

### Municipal and Industrial Water

Municipal water for the Pueblo is supplied by wells. This supply of water is adequate in quantity and quality. As the needs increase with the population growth, additional wells can be developed.

### Fish and Wildlife

Rangeland wildlife habitats have been damaged by erosion and reduction of plant species' diversity and abundance. These damages are attributed to past overutilization by domestic livestock, and to a lesser degree by the mechanical removal of trees and shrubs.

The rangeland habitats are deficient in abundance of preferred browse species needed for nutritious winter food supplies for mule deer. The limited herbage plant composition, further stressed by domestic grazing practices, fails to produce sufficient seeds during the winter months to support many resident scaled quail.

### Economic and Social

Farm income on the Zuni Reservation is limited and it must be supplemented by off-farm employment in order to provide even a modest standard of living. Limited non-farm employment opportunities prevent many families from supplementing their farm income. Economic development has been hindered by several local problems having to do with conservation and development of land, water, and other related resources. These problems include limited monetary and human resources for planning and applying needed land treatment measures. Also, insufficient funds have delayed the construction for control measures of floodwaters from Oak Wash. Controlling floodwaters is a prerequisite to many of the urban developments within the Pueblo for providing employment opportunities. The area has the unifying influence of a large Indian population. The Navajo Reservation encompasses a large portion of the area in the subregion. The average per capita income for the subregion is \$1,562 while the per capita income for the Pueblo of Zuni is \$906. The average per capita income for the United States is \$3,910. The Zuni Comprehensive

Development Plan, dated July 1969, states, "The Pueblo is too poor to fully participate in the 'War on Poverty'".

### P R O J E C T S   O F   O T H E R   A G E N C I E S

There are no known existing or future water resource development projects that have a direct relationship to the works of improvement included in this project, except the planned enlargement of Black Rock Reservoir. Personnel of the Bureau of Indian Affairs are investigating alternative methods to provide additional storage for irrigation water. The additional irrigation water is needed to achieve full development of about 900 acres of cropland within the watershed that cannot be irrigated due to an inadequate source of supply.

A special flood hazard report has been completed by the Corps of Engineers, U.S. Army Engineer District, Los Angeles. The purpose of the report is to present information on the flood hazard along the Zuni River in the Pueblo of Zuni. The reach of the Zuni River studied in this report includes a section approximately 2-1/4 miles in length that begins about 1/4 mile east of Zuni High School. Land use in the floodplain is primarily agricultural; however, local officials anticipate substantial development in the future. Data in the report can be used as a basis for further planning toward optimum use and development of flood-prone areas. Such planning would include controlling the construction of buildings, constructing flood control projects, or by a combination of these and other methods of floodplain management.

The Pueblo of Zuni is currently carrying on an improvement program within the urban area. This program includes street and road improvements, internal drainage system, reorganization of the sanitary sewer system, and improvements to the utilities.

### P R O J E C T   F O R M U L A T I O N

An application for assistance in developing the watershed under Public Law 566 was prepared in July 1969 by the Zuni Tribal Council and the McKinley Natural Resource Conservation District. This application covered two other major drainages in addition to Oak Wash. A preliminary investigation followed the application and was completed in November 1970. The investigation indicated that a feasible project could be developed under the provisions of Public Law 566 on Oak Wash. Little opportunity existed for feasible project type development on the other two drainages. Authorization was granted May 24, 1971 to provide planning assistance to the sponsors for making investigations and surveys necessary to develop this watershed work plan.



An initial formulation meeting was scheduled and held by the sponsors on June 15, 1971. This was a general formulation meeting for discussing the proposed watershed development, resource inventories, land treatment, environmental effects, structural measures, and other information. Written notices were mailed to about 25 concerned agencies, individuals, and groups, that included a request for data or pertinent information useful in planning investigation and formulation studies.

The sponsors held meetings throughout the planning process to keep the general public informed and to provide opportunities for organizations, agencies, and individuals to: (a) participate in the development of the objectives; (b) consider wide range of alternatives; (c) raise issues; and (d) provide inputs.

The more important meetings, in addition to the one discussed above, were held on October 7, 1971; January 25, 1972; April 13, 1972; September 20, 1972; and April 1973. During the planning process it was determined that the other two major drainages, excluding Oak Wash, could not be feasibly developed under the provisions of the Act. This application was amended to exclude these drainages in September 1972.

### Objectives

The development of the project was accomplished basically through the coordinated efforts of the local sponsors, Bureau of Indian Affairs, Four Corners Regional Commission, State of New Mexico, and the Soil Conservation Service. The approach to the project formulation was based on objectives to provide an effective treatment to the major problems existing in the watershed. The objectives are:

1. To provide watershed protection through effective land treatment and management of related resources. The goals are to have 80 percent or more of the total land treatment needs on the land at the end of the project installation period. This minimum level was set to prevent further deterioration of the watershed lands.
2. Provide control of the floodwater from the Oak Wash drainage area to provide 100-year flood protection to the Pueblo of Zuni and surrounding irrigated agricultural lands. The level of flood protection to the agricultural lands is to be the same as for urban property since the agricultural lands are closely located around the urban area.
3. To eliminate sediment deposition and resulting damage on the urban and agricultural floodplain from storms up to and including the one percent chance event (100-year frequency).



The local people expressed a desire to control a minimum of 90 percent of the drainage area contributing to floodwater and sediment damage if possible.

Land treatment measures and systems in this plan were formulated to provide for the conservation and development of the agricultural lands. They are to reduce sediment production, nutrient losses and erosion, and increase grazing production. Land treatment systems are based on soil and range inventories. These were accomplished by technicians from the Soil Conservation Service and Bureau of Indian Affairs. The inventories were evaluated, analyzed, and explained to the land users. The land users in turn developed the planned treatment, with assistance from the Soil Conservation Service and the Bureau of Indian Affairs. (See Figure 3.)

Land treatment and non-structural measures were given first consideration in obtaining or solving the project objectives. Structural measures were then considered to meet and accomplish the desired objectives which were not accomplished through the land treatment program.

#### Environmental Considerations

The project will cause or induce no downstream damages. The Oak Wash drainage joins the Zuni River just south of the Pueblo. This drainage is only one of the smaller tributaries to the river and its control will have no significant effect on reduction in flood stages along the river floodplain.

There will be no displacement of people by the installation of the works of improvement. Presently, three grazing allotments are located within the proposed sediment basin and floodwater detention pool. These lands are owned by the Zuni Tribe and the grazing allotments can be relocated at no cost.

#### Alternatives

##### a. Land Treatment Only.

This alternative consists of applying land treatment on the rangeland. Land treatment would include proper grazing use, range deferred grazing, stockwater development, brush control, range seeding, and erosion control. The estimated cost for the land treatment is \$55,900.

This alternative would be beneficial in meeting the need for sustained and increased forage production. These practices will improve the ground cover, increase livestock forage production, improve the quality of forage, and increase food and cover for wildlife.

The land treatment program alone would not provide adequate treatment for significantly reducing runoff and sediment yields. Flooding through the irrigated agricultural lands and the Pueblo of Zuni would continue. This would tend to discourage farmers from completing land treatment systems for the irrigated cropland and pastureland. Approximately \$184,650 of the average annual damages occurring from floodwater would still occur.

b. Floodproofing and Zoning with Land Treatment.

This alternative consists of establishing the limits of flooding for the 100-year flood and instituting zoning regulations for further planning toward optimum use and development of the flood-prone area. In addition, the existing developments would be flood proofed through the raising of foundations or some method of insuring that the developments were protected from potential damage. Land treatment would be applied on the rangeland portion of the watershed.

The present development in the 100-year floodplain would remain and future improvements would be restricted to projects that would not contribute to the flooding problem nor be susceptible to flood damage. These types of improvements could be parking lots or recreation areas. Floodproofing to the 100-year level would cost approximately \$4,500,000 including costs for sediment removal and maintenance. This cost would be the responsibility of the land-owners. All types of improvements would need to be floodproofed for water depths of about three feet. Protection would be provided to 543 homes, 4 commercial buildings, 2 schools, 1 church, 1 mission, 1 school teacherage with 16 units, and the jail. Positive control of floodwater and heavy sediment transports would not be realized. A potential hazard would remain for loss of life and to public utilities. The sediment deposition would create severe dust and air pollution when they dry out and begin to blow. The impacts and benefits of the land treatment would be the same as listed under the alternative for land treatment only.

c. Floodway with Land Treatment.

This alternative consists of constructing a floodway to safely convey the flood flow from Oak Wash into the Zuni River. Land treatment would be applied on the rangeland and irrigated land. The channel would be constructed around the Pueblo on the west side and empty into the Zuni River. The channel would be about 800 feet wide and 16,000 feet in length. It would require about 300 acres of which 90 percent would be from the irrigated lands. A minimum five-foot dike would be required on each side to contain the flows.

Large concrete drop structures are needed to reduce the gradient to achieve a stable waterway. A large bridge would be needed to

permit the flows to pass under State Highway 53. The estimated construction cost for this alternative is \$3,500,000. This alternative would provide protection to the Pueblo of Zuni and the surrounding cropland for the 100-year storm.

The land treatment for the rangeland would be the same as for the land treatment only alternative. Since the surrounding irrigated lands would be protected, complete land treatment could be installed on these lands with confidence. The benefits and impacts of the proposed land treatment program would be realized. The channel would be in close proximity to the urban area of the Pueblo. Sediment yield into the Zuni River would be greatly increased. The estimated cost of the land treatment would be about \$965,900.

d. No Project.

This alternative would deprive the area of \$313,620 in benefits. Floodwater, erosion, and sediments would continue to damage urban and agricultural improvements. Farm operations would continue to be downgraded. Approximately 1,440 acres of floodplain would be without protection from floodwater and sediment. The vegetation or natural stream regime would not be disturbed. Other impacts would remain in their present conditions as described in the problems section.

The sponsors selected the floodwater retarding structure with land treatment. They considered this alternative to provide the framework of assistance for the full development and stabilization of the total resources and economy of the watershed. Multi-purpose objectives were considered to include storage for irrigation, fish, and wildlife. Development of the water budget revealed that the average annual evaporation will offset the average annual yield of runoff at the floodwater retarding structure site, measuring about 500 acre-feet. Therefore, the yield is not adequate to support multi-purpose objectives.



## WORKS OF IMPROVEMENT TO BE INSTALLED

### Land Treatment Measures

Land treatment measures to be installed are shown in Table 1. The measures shown will be applied on Indian lands and state-leased lands in the combinations needed to achieve proper use and adequate treatment. This will be achieved by land operators through complete conservation plans with the McKinley Natural Resource Conservation District.

Land treatment practices such as proper grazing use, deferred grazing, livestock water development, brush management, and range seeding will be applied in the uplands. Grade stabilization structures and debris basins will be installed in most of the small water courses to reduce velocity of water and to control headcutting. Adequate fences and livestock water facilities are necessary before a desirable deferred grazing system can be initiated. Needed facilities have been identified in conservation plans with the McKinley Natural Resource Conservation District and will be installed according to schedule.

Land treatment measures such as conservation cropping systems, crop residue management, hayland planting, hayland management, pasture planting, and pasture management will be applied on the irrigated cropland. In addition, irrigation systems will be installed and managed so that high efficiency in water application and use can be achieved.

Technical assistance will be provided in planning and application of the land treatment systems by the Soil Conservation Service and the Bureau of Indian Affairs.

### Structural Measures

One floodwater retarding structure will be constructed to provide protection to floodplain lands. The structure will collect and control the sediment and runoff from 13.4 square miles of drainage area which is 94 percent of the area contributing runoff into the problem area. The locations of the structural measures are shown on the project map.

The dam will be an earthfill with a compacted earth core. It will be about 60 feet high and approximately 7,000 feet long. The capacity of the dam below the crest of the emergency spillway is 4,736 acre-feet. Of this, 3,913 acre-feet is for the anticipated 100-year sediment volume, and 823 acre-feet is for detention storage to retard the 100-year storm runoff. The embankment will be vegetated. It will also be fenced to provide protection from

*-Works of Improvement to be Installed-*

grazing and other factors that would be detrimental to the structure. (See Figure 1 and Figure 4.)

The dam will be constructed of compacted earthfill. Materials available for borrow in the reservoir are silty sands (SM) and clays of low plasticity (CL).

The dam will be constructed over a foundation of CL and SM materials. Depth to rock is estimated to be 30 feet or more. Minor settling can be expected, but large differential settlements are not anticipated. The principal spillway can be set on a uniformly yielding foundation.

The principal spillway is planned as a 30-inch diameter reinforced concrete pipe supported by a concrete cradle. The inlet riser will be provided with an ungated opening, sized to drain the flood volume produced by a 25-year, 6-hour storm, in a maximum of 96 hours. The crest of the riser will be set at the top of the 100-year sediment pool (Table 3). The principal spillway will discharge through a 36-inch diameter reinforced concrete pipeline, approximately 8,000 feet in length, through an energy-dissipating structure (impact basin) into the Zuni River. A pressurized manhole will be provided in the connecting box at the end of the principal spillway. Pressurized manholes will be provided every 1,000 feet along the pipeline. The floodwater retarding structure will have a dry pool.

A concrete emergency spillway with an energy dissipating outlet is planned in the left abutment. The emergency spillway and principal spillway have a combined capacity to pass the routed freeboard hydrograph without overtopping the dam.

Installation of structural measures will require land rights to be obtained on a total of 652 acres. The minimum land rights required will be those necessary to construct, operate, maintain, and inspect the structural works of improvement; to provide for flowage of water in, upon, or through the structures; and provide for the permanent storage and temporary detention, either or both, of any sediment and water. The land rights include a flowage easement up to an elevation of 6,388.3 feet or about 280 acres. This area includes 225 acres for the retarding pool and 210 acres for the sediment pool. The borrow area consists of about 130 acres and is located within the sediment pool.

The installation of the floodwater retarding structure will require the commitment of 45 acres of rangeland for the dam and spillway. The land rights for the installation of the pipeline will require 13 acres. Of the 13 acres, about 3 acres are located in rangeland, and 10 acres will be located in cropland. An additional 314 acres are needed for a temporary easement for construction operations.

These areas will not be available for public use. There will be no required alteration, modification, or change in location of existing improvements.



The archeological center of the University of Arizona and the National Park Service provided information on the location of places of archeological or historical value in the construction area. The Arizona State Museum has prepared a proposal for further archeological investigation in the project area. This is included in the report, "Impact of the Oak Wash Dam Project on Archeological Sites Near Zuni, New Mexico" by Ric Windmiller, dated April 23, 1973. This proposal provides for the systematic recovery of data from 18 sites.

The program would involve adequate data recovery to provide a broad range of information regarding the structure, content, and age of the sites. It would permit inferences concerning the social groupings resident at the site, their activities, and the relationships between sites.

Both testing and intensive excavation are recommended as the first step in mitigation. Since it was impossible to determine the extent of a number of sites from surface collections alone, initial testing is recommended for these sites prior to planning and funding of the full scale excavation.

The detailed archeological investigations are planned to be carried out in two complimentary phases. Phase One is excavation and testing of sites with high probability of destruction from dam construction and floods predicted for 100-year intervals or less. This will require initial testing and possible further excavation of two sites: ZOW 4 (N.Mex.G:13:22) and ZOW 5 (N.Mex.G:13:23). Excavation will be necessary at five sites: ZOW 6 (N.Mex.G:13:24), ZOW 11 (N.Mex.G:13:29), ZOW 13 (N.Mex.G:13:31), ZOW 14 (N.Mex.G:13:32), ZOW 15 (N.Mex.G:13:33), ZOW 19 (N.Mex.G:13:37). Phase Two will require initial testing and possible further excavation of two sites: ZOW 16 (N.Mex.G:13:34) and ZOW 17 (N.Mex.G:13:35). One site, ZOW 12 (N.Mex.G:13:30) should be excavated, and further excavation of ZOW 4 and ZOW 5 may be necessary. To avoid further impact on archeological resources, borrow sites will be located at sites where intensive surveys by a professional archeologist established that there are no significant archeological resources.

The National Register of Historic Places has been consulted and no properties in McKinley County listed on the National Register will be affected by the Oak Wash Dam project.

Preventative measures will be taken to minimize soil erosion during construction. Cover will be maintained wherever possible. All disturbed areas will be reseeded, and where necessary, mulched and irrigated to re-establish cover. The dust and noise pollution will be controlled during construction through monitoring, good equipment, good construction practices, and good agency-contractor cooperation. Dust pollution tolerances will be set with suitable measures taken to maintain the pollution at, or below, the predetermined

*-Works of Improvement to be Installed-*

pollution level. Proper attention will be given to workers' safety, proper clothing, and occupational health measures. Provisions will be made during installation for permanent recording of the types of chemicals (if any) that would be applied to the land, the rate of application, and the total quantities of chemicals used.

## EXPLANATION OF INSTALLATION COSTS

The estimated cost of installing land treatment measures is \$965,900, of which \$39,100 is on state land and \$926,800 is on the Zuni Reservation. These figures include \$121,200 for technical assistance in planning and supervising establishment of the measures. The Soil Conservation Service will provide about \$8,000 of this amount from regularly appropriated funds. The Bureau of Indian Affairs will provide \$113,200 for technical assistance for the installation of land treatment on the Zuni Reservation.

Land users will be responsible for \$844,700 for the cost of the application of the land treatment. Cost-sharing of the land treatment is available through the Rural Environmental Conservation Program.

The total estimated installation cost of the structural measures is \$3,861,100. A tabulation of installation cost items for the structural measures is included in Table 2. Estimated Public Law 566 cost for structural measures is \$3,644,500, and the cost to funds other than Public Law 566 is \$216,600.

Public Law 566 funds will bear the estimated construction costs of \$3,053,900; the engineering costs of \$244,000; and \$346,600 for project administration. Funds from other sources will bear \$3,000 for the cost of project administration; \$8,600 as the estimated value of land rights; and \$205,000 for archeological excavation.

Included in the construction costs are clearing, site preparation, earthfill, excavation, spillways, pipeline, and cost of construction water. These costs include a 20 percent contingency allowance for unforeseen costs on all construction items.

Engineering costs include geologic foundation investigations, construction materials investigation, engineering designs, and preparation of plans and specifications. Engineering costs are estimated to be \$244,000.

Project administration costs include administration costs, contract administration, review of engineering plans by others, construction surveys, and inspection during construction. The estimated Public Law 566 cost of project administration is \$346,600, of which \$184,000 is for construction inspection and \$162,600 is for other costs of project administration.



*-Explanation of Installation Costs-*

The cost of project administration to the local sponsors is estimated to be \$3,000. This includes cost of time in meetings and other miscellaneous overhead costs.

The sponsoring local organizations will secure all land and water rights needed for the installation of the structural measures. The structural measures are located on the Reservation lands. The land rights costs are estimated to be \$8,600.

The \$205,000 for archeological cost includes salvaging, testing, and analysis reports. The National Park Service is programming funds for the detail archeological studies and salvaging.

The estimated obligation of funds for each fiscal year during the project installation period is shown in the following tabulations:

LAND TREATMENT MEASURES - Other Funds (Dollars)					
Year		Technical Assistance		Land	
	SCS	BIA	Treatment	Total	
1st	500	5,000	15,000	20,500	
2nd	500	5,000	15,000	20,500	
3rd	500	5,000	15,000	20,500	
4th	1,300	19,000	159,000	179,300	
5th	1,300	19,000	159,000	179,300	
6th	1,300	19,000	159,000	179,300	
7th	1,300	19,000	159,000	179,300	
8th	1,300	22,200	163,700	187,200	
TOTAL	8,000	113,200	844,700	965,900	

STRUCTURAL MEASURES (DOLLARS)		
Year	Public Law-566 Funds	All Other Funds
2nd	1,644,500	216,600
3rd	1,000,000	
4th	1,000,000	
TOTAL	3,644,500	216,600



## E F F E C T S   O F   W O R K S   O F   I M P R O V E M E N T

### Flood Prevention, Erosion, and Sediment

Installation of land treatment practices such as proper grazing use, deferred grazing, livestock water development, and range seeding in the uplands will increase the vigor, stand, and productivity of forage plants. Continued treatment and improvement of the range-land resource in the watershed will create a demand for additional hay. These treatment practices are estimated to reduce erosion in the uplands by five percent. All cover improvements which result from this management will serve to lengthen the useful life of the floodwater retarding structure due to reduction in sediment yields that may occur.

Conservation treatment of irrigated land will result in more efficient use of irrigation water, reduce erosion, reduce nutrient loss, and make better use of rainfalls. Installation of land treatment practices such as conservation cropping systems, crop residue management, and pasture and hayland management will help protect the soil from erosion by water and wind, and help to maintain the productivity of the soil for a sustained agriculture. The proper management of irrigation through better distribution facilities and methods of application will reduce waste of water.

These structural measures will not control the flooding along the Zuni River floodplain caused by the flood flows from the Zuni River. (Refer to Figure 5.) The floodplain of the Zuni River was determined by a study completed by the Corps of Engineers.

The structural measures included in this plan will reduce average annual floodwater and sediment damages resulting from the Oak Wash drainage area to the agricultural and urban land below the structure by 100 percent. The measures will control 94 percent of the contributing drainage area above the Zuni Irrigation Canal for storms ranging up to the 100-year event. The drainage area that is not controlled consists of 0.9 square miles above the irrigation canal and drains through the west side of the irrigated cropland. This drainage has been treated with debris basins that will store the 10-year sediment accumulation and control runoff up to the 10-year storm. The damage from this drainage area is negligible for all storms ranging up to the 100-year event and will affect only the cropland on the west side.

There will be approximately 0.75 square miles of drainage area below the floodwater retarding structure. This area will drain into the urban area of the Pueblo. The runoff from this area will be controlled by land treatment measures to be planned and installed after completion of the structural measures. The internal drainage system being installed in the Pueblo of Zuni in the urban area will provide some relief until land treatment measures are installed.

*-Effects of Works of Improvement-*

The floodwater retarding structure and associated outlet works only provide a level of protection up to the 100-year frequency storm. The structure is designed to safely pass the peak flow from the storm generated by the probable maximum precipitation. Flows begin to pass through the emergency spillway once the 100-year frequency is exceeded. In view of this limitation of the project, high damages and possible loss of life could result from a false sense of security. The Pueblo of Zuni will periodically bring this to the attention of the people. Even though damages occur from storms larger than the 100-year event, some damage reduction would be realized from the works of improvements during these storms. One hundred and fifty-one acres within the Pueblo limits would be protected from a storm having a one percent chance of occurrence.

In addition, 543 families will benefit from reduced floodwater and sediment damage to their homes from a storm having a one percent chance of occurrence. Two hundred and twenty-one families would benefit from protection during a storm having a 20 percent chance of occurrence. In addition to the 543 homes, four commercial businesses, two schools, a church, a mission, a school teacherage of 16 units, and the local jail will receive protection. With the project installed, the hazards to health and life are essentially eliminated.

The area benefited by the project also includes 1,440 acres of irrigated land. Protection provided to these lands from a storm having a one percent chance of occurrence will be an incentive to return 834 acres of idle irrigated land to cropland production. This would also permit more intensive use of the 666 acres of irrigated land presently in cropland production. An incentive would be provided to develop needed irrigation water for full utilization of an additional 900 acres of idle land. The project would prevent damage to the main irrigation canal alleviating interruptions and loss of irrigation water.

Based on synthesized data, the peak flow from a storm equivalent to the 1970 storm would be reduced to approximately 710 cubic feet per second. About 90 percent of the sediment yield from the watershed above the irrigation canal would be collected by the structure with about 4.3 acre-feet being delivered directly to the Zuni River. The concentration of sediment in the water delivered to the river is estimated to be 8,600 parts per million (p.p.m.). For all practical purposes, this is clear water and will not adversely affect the main-stream water quality.



## Fish and Wildlife

The construction of the floodwater retarding structure and the pipeline will temporarily disturb ecological functions on about 190 acres consisting of rangeland and cropland. This area will be lost for wildlife and agricultural uses until the embankment and disturbed areas are revegetated after construction.

Agricultural and wildlife use will be occasionally interrupted on the 280 acres used to store sediment and floodwater. The periodic inundation will provide additional effective moisture which will induce an improvement in vegetative composition and production, thus increasing food for both livestock and wildlife.

The project will cause more intensive land use on about 1,500 acres of irrigated land. Much of this acreage is expected to go into the production of hay. The effect will be an increase in perennial herbage, and a diversification of vegetable and small grain crops. Communities of wild animals will change, as will populations, but the net effect is expected to be an improvement in food supplies and permanent cover types available to resident and migratory species. Land treatments planned for the rangelands of the watershed will cause major changes in vegetative composition and diversity and will in turn influence communities of wild animals.

Since 1966 there have been about 1,700 acres of pinon and juniper cleared by mechanical methods. About 1,500 acres of this area will be recleared. An additional 1,200 acres of pinon-juniper or sagebrush will be cleared, some by hand cutting. The removal of these amounts of tree and shrub species will reduce the availability of nesting sites for some bird species. In addition, there will be a concurrent loss of tall cover available for escape or protection from the weather.

Improvements of perennial grasses will occur on about 850 acres of range seeding and 115 acres of pasture planting. Together with planned cross fencing and improvements in grazing management, these treatments will improve herbaceous composition and density over much of the rangeland. The addition of cool season grasses into the plant composition will improve the existing gap in early season forage availability. These treatments are expected to provide improved habitat conditions for scaled quail, and ground nesting and feeding songbirds. There will be a reduction in small rodents which will lead to fewer predatory species.

The general improvement in range forage conditions, together with improved management of livestock, will reduce the grazing intensity on the small mesas and breaks. These scattered areas, totaling 2,500 acres, are expected to show a favorable response in the growth and reproduction of browse plants. Improved production of browse will benefit mule deer.

While wildlife populations residing in the proposed construction areas are low, there will be a temporary disruption of normal activity during the periods of construction. Following completion of construction it is expected that wildlife populations will readjust to the carrying capacity of the new habitat. A potential hazard for a few small animals that may drown will be created when the detention pool fills rapidly.

### Archeological, Historical, and Scientific<sup>1/</sup>

Archeological resources constitute a fragile record of previous human occupation, discernible only through carefully planned and professional excavation and analysis. Such resources are finite in number, and are non-renewable. Any alteration of the ground surface in and around archeological sites destroys context. In turn it reduces the amount and quality of information potentially available for future scientific and interpretive use.

One archeological site (ZOW 15) will immediately be destroyed by dam construction and a second site (ZOW 6) is near enough to be threatened by dam construction, and is low enough to be threatened by frequent flooding and runoff. Six sites (ZOW 4, 5, 11, 13, 14, and 19) lie below the 100-year flood line and will be subjected to long-term destruction by erosion, sedimentation, and periodic flooding. Three other sites (ZOW 12, 16, and 17) are situated below the maximum pool elevation and are exposed to potential flooding and erosion because of the dam. The remaining seven sites are located above the spillway level and will not be affected by the project. This cluster of 18 sites located in the dam area represents a significant settlement complex. The total complex must be considered as the resource to be affected by the dam.

The commitment of land for construction of the Oak Wash Dam will have direct effects upon the archeological resources in the project area that will be affected by construction or flooding. Any commitment of archeological resources, whether to construction, vandalism, or even mitigating salvage excavation, results in a net loss in the total amount of archeological information remaining for future study and interpretation.

### Economic and Social

Based on average anticipated conditions, it is estimated the project would provide nearly 175 man-years of employment during the installation period. An undetermined amount of employment would also be generated in the production of secondary benefits subsequent to the installation of the project. Considering the anticipated eight-year project installation period and the average annual unemployment rate, it is estimated that unemployment could be reduced

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<sup>1/</sup> This information furnished by the National Park Service and Arizona State Museum, University of Arizona, Tucson, Arizona.



by an average of five percent annually. After completion, secondary benefits will continue to provide a low level of increased employment.

Agriculture is one of the predominant long-term economic bases of the area. The idle irrigated lands would be returned to production. The agricultural efficiency would be improved by the project. Crops could be planted with confidence at earlier dates. The need for replanting would be eliminated, thereby saving considerable added costs. Delayed harvesting would be eliminated and the risk of having to harvest immature crops due to the lateness in the season would be avoided. More efficient and increased use of fertilizer can be obtained. The surface of the fields would remain level, reducing wear and tear on machinery and saving maintenance costs. Improved efficiency of farm operations and improved farm income because of the project would provide incentive for full utilization of farm land.

Secondary benefits are those arising from the increased production of goods and services as a result of the project. They also include benefits induced by the project. The induced benefits are increased expenditures by people in the area. They are estimated to be 10 percent of direct damage reduction and annual operation and maintenance costs. The secondary effects will be significant in the subregion.

Intangible project benefits will be an opportunity to shift funds from repairing damages to investing in schools, libraries, and other facilities that improve the quality of living.

Other effects will be the creation of some noise and dust pollution during construction and disruption of the natural landscape by the earth structure.

### P R O J E C T   B E N E F I T S

Benefits from land treatment measures will be primarily on-site conservation benefits that will come from more efficient land and water management.

Monetary benefits are shown in Tables 5 and 6. The structural measures included in the plan will reduce the estimated average annual flood damages and will provide damage reduction benefits of \$184,650.<sup>1/</sup> These average annual benefits consist of \$161,580 in the reduction of direct flood damages and \$23,270 in the reduction of indirect flood damages. The project will allow for more intensive land use on 666 cropland acres with benefits of \$17,540, and changed land use on 834 cropland acres with benefits of \$30,600.

With the development of the resources in the watershed and on the Zuni Reservation, homes will increase beyond those presently planned

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<sup>1/</sup> Land treatment measures will result in an additional annual flood reduction benefit of \$200.

through 1975. This development will continue within the present Village limits (limits of water and sewer lines), part of which is on the Oak Wash floodplain. Damage reduction benefits to future homes after 1975 were not evaluated.

Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation and were not included in the economic analysis. Secondary benefits at the local level are significant and were estimated to be \$25,360. The secondary benefits were induced by and stem from project measure installation. Redevelopment benefits from increased employment during the installation period and from operation and maintenance will be \$55,470.

The allowance for sediment storage in the floodwater retarding structure is nearly five times that needed for the retarding storage for a good portion of the 100-year sediment life. The actual volume available for retardation is at least twice that needed to contain the 100-year storm runoff. Therefore, the structure is providing damage reduction benefits over and above those accounted for in the evaluation. These are not considered pertinent to the economic evaluation from a national point of view. These benefits at the local level are significant, but monetary benefits were not claimed and used in project justification.

#### COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation and project administration costs plus operation and maintenance costs) is \$233,710. Total average annual benefits are estimated to be \$313,620. This results in an overall benefit cost ratio of 1.3:1.0 (Table 6).

The installation of structural measures included in the plan will produce estimated average annual total benefits excluding secondary benefits of \$288,000. The ratio of these benefits to the cost of the structural measures is 1.2:1.0.

#### PROJECT INSTALLATION

The major part of the planned land treatment will be accomplished during the eight-year installation period (Table 1). The McKinley Natural Resource Conservation District and the Bureau of Indian Affairs will provide the needed technical assistance to complete the work as outlined. Each landowner will use the existing cost-share programs to the fullest extent possible. Low cost labor, through the Neighborhood Youth Corps program, will be used by the Zuni Tribe for practices involving hand labor. If possible, these will be made available to the other land users.

Structural measures will be installed in a three-year period. Construction of these measures will start when the project is



approved, when all necessary land easements and rights-of-way have been obtained, when operation and maintenance and project agreements have been executed, and when federal funds are available.

A construction schedule will be agreed upon by the cooperating parties and coordinated with the archeological investigations and salvage. It will be adjusted on the basis of any significant changes in the plan found necessary due to appropriations and progress actually made. The various features of cooperation between the sponsors and the Service will be covered in appropriate memoranda of understanding and in working agreements.

The Pueblo of Zuni has the power of eminent domain and is willing to exercise these powers. They will be responsible for land rights acquisition. All structural works of improvement are located on Reservation lands, although the pipeline crosses State Highway 53. A construction permit will be needed from the New Mexico Highway Department to place the pipeline under the highway.

The sponsors will submit all plans and specifications for the structural measures to the New Mexico State Engineer for filing and approval. The sponsors will also comply with applicable state laws before invitations to bid are issued.

The Soil Conservation Service will let and service the construction contracts for the structural measures, as the local organizations have formerly made this request.

The Soil Conservation Service will provide technical assistance in preparation of plans and specifications, supervision of construction, preparation of contract payment estimates, final inspection, certification of completion, and other related work cost-shared with Public Law 566 funds.

The Soil Conservation Service will provide construction funds for the floodwater retarding structure with the associated outlet works and pipeline.

The following minimum conditions shall be met before issuance of invitations to bid:

1. All necessary land rights and permits for construction must be obtained. All land rights needed are within the Zuni Reservation.

2. Mutual agreements concerning the schedule for construction and for plans and specifications shall be reached. Terms of contracts and all matters pertaining to contracts or to works of improvement shall be mutually satisfactory and in accordance with requirements of the sponsors and in agreement with the Soil Conservation Service technical and administrative requirements.

3. Full conformance with county, state, and federal laws and regulations shall be the responsibility of the sponsors and shall be secured with no expenditure of Public Law 566 funds. Reasonable evidence of conformity shall be presented to the mutual satisfaction of all parties.

#### FINANCING PROJECT INSTALLATION

The cost of land treatment measures to be applied on state lands will be the responsibility of the lease holder. The cost of land treatment measures to be applied on the Zuni Reservation lands will be the responsibility of the Pueblo of Zuni. Technical assistance will be available from the Soil Conservation Service and the Bureau of Indian Affairs.

The Pueblo of Zuni has authority under state law to levy assessments on real property, borrow such money as necessary and acquire needed land rights, and to carry out their responsibilities in the installation of the project.

Federal financial assistance in carrying out the project will be made available to the local organizations when the necessary land rights are obtained and when federal funds are available. Federal funds are contingent on appropriations made under Public Law 566. Funds for the detail archeological studies and salvaging will be made available by the National Park Service.

#### PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures applied on state-owned land will be maintained by the operator. The operator has a cooperative agreement with the McKinley Natural Resource Conservation District. The Pueblo of Zuni will maintain land treatment measures installed on the Zuni Reservation lands.

Representatives of the local organizations and the Soil Conservation Service will make a joint inspection of the structural measures annually and after each major flood for three years following installation of the structure. The inspections will be made to determine the need for maintenance and repair. Inspections after the third year following installation will be made annually by the sponsors and a report prepared by them. The Service will participate in annual inspections as often as it elects to do so after the third year. A copy of the report will be furnished to the Soil Conservation Service.

Maintenance of the structural measures shall include but not be limited to:



*-Provisions for Operation and Maintenance-*

1. Keeping all structures in serviceable condition by making replacements and repairs as needed. Items to be considered are the condition of the principal spillway, emergency spillway, earthfill of the floodwater retarding structure, the pipeline including all appurtenances, and vegetative cover on the embankment.

2. The sponsoring local organizations will effectively and in a timely manner perform all necessary maintenance and will operate the entire project in accordance with legal permits granted for construction.

3. Damage to the structural measures caused by large storms will be repaired by the local sponsors as part of the maintenance program.

The operation and maintenance of the structural measures will be the responsibility of the Pueblo of Zuni. The estimated average annual operation and maintenance cost for the structural measures is estimated to be \$6,100.

The Pueblo of Zuni and the Soil Conservation Service will enter into a specific operation and maintenance agreement in accordance with provisions in the Soil Conservation Service Operation and Maintenance Handbook of New Mexico prior to signing a project agreement.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

## ZUNI PUEBLO WATERSHED, NEW MEXICO

Installation Cost Item	Unit	Number		Estimated Cost (Dollars) <sup>1/</sup>					Total	TOTAL	
		Non-Fed. Land	Total	P. L. 566 Funds		Other					
				Non-Fed. Land	Total	Non-Federal Land	Other	Total			
											SCS <sup>3/</sup>
<b>LAND TREATMENT</b> <sup>2/</sup>											
Land Areas	Acres to be treated										
Cropland	1,460	1,460					650,200	650,200		650,200	650,200
Pastureland	330	330					138,600	138,600		138,600	138,600
Rangeland	7,930	7,930					31,100	24,800		55,900	55,900
Technical Assistance							8,000	113,200		121,200	121,200
<b>TOTAL LAND TREATMENT</b>		9,720	9,720				39,100	926,800		965,900	965,900
<b>STRUCTURAL MEASURES</b>											
Construction	No.										
Floodwater Retarding Structures with Associated Outlet	1			3,053,900	3,053,900						3,053,900
Subtotal - Construction				3,053,900	3,053,900						3,053,900
Engineering Services				244,000	244,000						244,000
Project Administration											
Construction Inspection				184,000	184,000						184,000
Other				162,600	162,600	3,000		3,000		3,000	165,600
Subtotal - Administration				346,600	346,600	3,000		3,000		3,000	349,600
Other Costs											
Archeological Land Rights						205,000		205,000		205,000	205,000
Subtotal - Other						8,600		8,600		8,600	8,600
<b>TOTAL STRUCTURAL MEASURES</b>				3,644,500	3,644,500	216,600		213,600		213,600	213,600
<b>TOTAL PROJECT</b>				3,644,500	3,644,500	255,700	926,800	1,182,500		1,182,500	4,827,000

<sup>1/</sup> Price base 1975.<sup>2/</sup> Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.<sup>3/</sup> Federal agency responsible for assisting in installation of works of improvement.

Date: June 1975

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

## Zuni Pueblo Watershed, New Mexico

Measures	Unit	Applied to Date	Total Cost (Dollars) <sup>1/</sup>
Brush Management	Acres	1,487	7,500
Conservation Cropping System	Acres	400	1,400
Crop Residue Management	Acres	400	2,200
Debris Basin	No.	15	66,400
Deferred Grazing	Acres	9,912	-----
Fencing	Feet	328,800	72,300
Grade Stabilization Structure	No.	600	15,000
Irrigation Canal or Lateral	Feet	29,000	725,000
Irrigation Field Ditches	Feet	40,000	20,000
Irrigation Land Leveling	Acres	200	24,000
Irrigation Water Management	Acres	200	-----
Pasture & Hayland Management	Acres	400	-----
Pasture & Hayland Planting	Acres	780	33,500
Proper Grazing Use	Acres	9,912	-----
Range Seeding	Acres	180	1,300
Structures for Water Control	No.	320	15,200
Well	No.	5	10,000
TOTAL	/////	////////	993,800

<sup>1/</sup> Price Base 1975

Date: June 1975



TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Zuni Pueblo Watershed, New Mexico  
1/  
(Dollars)

I t e m	Installation Cost -			Installation Cost -			Total
	P.L. 566 Funds			Other Funds			
	Con- struction	Engi- neering	P.L. 566	Archeo- logical	Land	Total Other	
</							

1/ Price Base - 1975.

Date: June 1975

TABLE 3 - STRUCTURAL DATA

## STRUCTURES WITH PLANNED STORAGE CAPACITY

## ZUNI PUEBLO WATERSHED, NEW MEXICO

Item	Unit	Structure Data, etc.
Class of Structure		c
Drainage Area	:Sq. Mi.	13.4
Curve No. (1-day)(AMC II)		83
Tc	:Hrs.	1.2
Elevation Top of Dam	:Ft.	6393.7
Elevation Crest Emergency Spillway	:Ft.	6383.5
Elevation Crest High Stage Inlet	:Ft.	-----
Elevation Crest Low Stage Inlet	:Ft.	6378
Maximum Height of Dam	:Ft.	53.7
Volume of Fill	:Cu. Yds.	1,500,000
Total Capacity <sup>1/</sup>	:Ac. Ft.	4736
Sediment Submerged 1st 50 yrs.	:Ac. Ft.	-----
Sediment Submerged 2nd 50 yrs.	:Ac. Ft.	-----
Sediment Aerated	:Ac. Ft.	3913
Retarding	:Ac. Ft.	823
Between High and low stage	:Ac. Ft.	-----
Surface Area		
Sediment pool	:Acres	Dry Dam
Retarding pool	:Acres	255
Principal Spillway		
Rainfall Volume (areal) (1 day)	:In.	2.8
Rainfall Volume (areal) (10 day)	:In.	4.0
Runoff Volume (10 day)	:In.	1.9
Capacity of Low Stage (Max.)	:cfs.	69
Capacity of High Stage (Max.)	:cfs.	-----
Frequency Operation-Emer.Spillway	:% chance	1%
Size of Conduit	:Inches	30
Emergency Spillway		
Rainfall Volume (ESH) (areal)	:In.	5.7
Runoff Volume (ESH)	:In.	3.8
Type		R/C chute
Bottom Width	:Ft.	150
Velocity of flow (Ve)	:Ft./Sec.	-----
Slope of exit channel	:Ft./Ft.	-----
Maximum water surface elevation	:Ft.	6388.3
Freeboard		
Rainfall Volume (FH) (areal)	:In.	10.0
Runoff Volume (FH)	:In.	7.9
Maximum Water surface elevation	:Ft.	6393.7
Capacity Equivalents		
Sediment Volume	:In.	5.48
Retarding Volume	:In.	1.15

<sup>1/</sup> Crest of emergency spillway.

Date: June 1975

TABLE 4 - ANNUAL COST

ZUNI PUEBLO WATERSHED, NEW MEXICO

(Dollars)<sup>1/</sup>

Evaluation Unit	: Amortization of 2/ : Installation Cost	: Operation and Maintenance Cost	: T o t a l
1	207,000	6,100	213,100
Project Administration	20,610	:	20,610
GRAND TOTAL	227,610	6,100	233,710

1/ Price base: 1975.

2/ 100 years @ 5-7/8 percent interest.

Date: June 1975

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS  
Zuni Pueblo Watershed, New Mexico

(Dollars) 1/ & 2/

	: ESTIMATED AVERAGE ANNUAL DAMAGE		: Damage
	: Without	: With	: Reduction
	: Project	: Project	: Benefit
Floodwater	:	:	:
Crop and Pasture	: 80	: -0-	: 80
Other Agricultural	: 3,780	: -0-	: 3,780
Nonagriculture	:	:	:
Residential	: 131,240	: -0-	: 131,240
Commercial	: 6,680	: -0-	: 6,680
Utilities	: 4,360	: -0-	: 4,360
Subtotal	: 146,140	: -0-	: 146,140
Sediment	:	:	:
Crop and Pasture & Other Agricultural	: 2,100	: -0-	: 2,100
Nonagriculture	:	:	:
Residential	: 2,300	: -0-	: 2,300
Commercial	: 6,680	: -0-	: 6,680
Utilities	: 4,360	: -0-	: 4,360
Subtotal	: 15,440	: -0-	: 15,440
Indirect	: 23,270	: -0-	: 23,270
TOTAL	: 184,850	: -0-	: 184,850 <sup>3/</sup>

1/ Price Base: Current normalized prices for crop and pasture, 1975 prices for all other.

2/ Damages and benefits will accrue from floods of greater magnitude than the 100-year storm, but were not evaluated.

3/ Figures in this table do not include the damages caused by the overflow of the Zuni River.

Date: June 1975



TABLE 6 - COMPARISON OF BENEFITS - COSTS FOR STRUCTURAL MEASURES  
Zuni Pueblo Watershed, New Mexico  
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS <sup>1/</sup>										Average <sup>2/</sup> Annual Cost	Benefit Cost Ratio
	Agricultural				Redevelopment	Secondary	Total					
	Damage Reduction	More Intensive Land Use	More Changed Land Use									
1	184,650	17,540	30,600	55,470	25,360	313,360					213,100	1.5:1
Project Administration	--	--	--	--	--	--					20,610	--
GRAND TOTAL	184,650 <sup>3/</sup>	17,540	30,600	55,470	25,360	313,620					233,710	1.3:1

1/ Price Base Current normalized prices for crop and pasture, 1975 prices for all others.

2/ From Table 4.

3/ In addition, it is estimated that land treatment installed in this watershed will provide \$200 annual damage reduction benefits in the project area.

Date: June 1975



# INVESTIGATIONS AND ANALYSES

## ENGINEERING

Aerial photographs and a study of historical floods showed that the Oak Wash drainage was the principal cause of flooding from runoff outside of the urban area. Possible methods of structural control were located and evaluated by considering topography, urban development in the Pueblo of Zuni, agricultural lands, and the degree of control afforded by the structural treatments. This area is not covered by U.S. Geological Survey topographic quadrangles.

Three floodwater retarding structure sites were tentatively located along Oak Wash drainage. Flood control measures at these sites were then evaluated. The lower site located immediately above the Zuni Irrigation Canal and the agricultural lands was selected as the most efficient site.

The following surveys were made to develop data for the detailed planning of the structural measures in this plan:

1. Differential level surveys to establish mean sea level elevations at the proposed structure site.
2. Topographic survey with four-foot contour intervals of the reservoir site. This survey was made by aerial photography and mapping procedures.

Elevation storage curves were made from the topographic maps of the reservoir sites for proportioning and flood routing.

The floodwater retarding structure was planned using the limiting criteria for proportioning earth dams and associated spillways as set forth in Engineering Memorandum SCS-27 (Rev.), Earth Dams, March 19, 1965, as supplemented.

Cost estimates were based on the quantity estimate from preliminary designs and the current unit prices for similar work in this locality. Where local cost information was not available, costs for similar construction in other areas were used after being adjusted to the local conditions. Contingencies in the amount of 20 percent were added to the engineer's cost estimates for the possibility of unforeseen costs.

The floodwater retarding structure was determined to be hazard classification "c" due to the potential loss of life and damage to valuable property in case of structural failure. Several alternative structure layouts with combinations of reinforced concrete emergency spillways and auxiliary earth spillways were evaluated.

## HYDROLOGIC INVESTIGATIONS

### General

The purposes included in the project are watershed protection and flood prevention. Hydrology studies were primarily concerned with:

1. Present conditions evaluated.
2. Future conditions without project.
3. Future conditions evaluation with project installed.
4. Computing principal spillway, emergency spillway, and freeboard hydrographs.
5. Reservoir routings for proportionment, design, and cost estimates.
6. Water budget analysis to determine probability of adequate yield from watershed for permanent storage.

### Stream Flow and Climatological

There are no stream-gaging stations located in this watershed. No miscellaneous measurement of peak flows was obtained.

One recording precipitation station is located in the watershed at the Zuni Airport (Black Rock). The station was established in 1957. Precipitation records from this station were analyzed to determine the one-hour precipitation amounts. These records were also used to develop precipitation and runoff relations for a water budget analysis.

Basic meteorologic and hydrologic data for the six-hour and 24-hour precipitation were obtained from the revised U.S. Weather Bureau maps (Isopluvials) dated June 1967. Rainfall amounts for probable maximum precipitation (freeboard hydrographs) were taken from Preliminary Draft - Probable Maximum Thunderstorm Precipitation Estimates - Southwest States, prepared by the Hydrometeorological Branch, National Weather Service, Washington, D.C., dated August 1972.

Available meteorological and hydrologic information concerning history of floods, precipitation, runoff, peak flows, and/or high water marks of floods of record were obtained from interviews with local people. Limited information was available, therefore synthetic storm series up to and including the storm having a one percent chance of occurrence were developed from the Technical Service Center's (TSC) Technical Note - Hydrology - PO-2.



### Surveys

The topographic survey made of the reservoir site was used to determine structure capacity. Channel cross-sections and profiles were surveyed to evaluate channels. Topographic surveys made of the flood damage area were used for evaluating areas and depths of flooding. Soil and range inventories were used in hydrologic studies.

### Historical Floods

Damaging floods usually occur annually. Some of the most damaging floods occurred in 1922, 1924, 1946, 1958, 1963, and 1965. Data relating to these floods and other floods were limited. Therefore, the floods could not be used for economic evaluation. The information available was used as a guide for locating areas flooded.

### Hydrologic Conditions

Soil and range inventories of the Zuni Indian Reservation were utilized to obtain basic soils and vegetative data for hydrologic classifications. Additional data was obtained by field reconnaissance and investigations to determine the soil-cover complex curve numbers.

### Times of Concentration

Times of concentration were computed by the Kirpich Nomograph. Velocities of flow given by those travel times were correlated with velocities as related by channel characteristics.

### Evaluation Hydrology

Evaluations were performed for: (1) present conditions; (2) future conditions without project; and, (3) future conditions with project.

Peak flows for the synthetic evaluation storm series were developed by the use of the Technical Note - Hydrology - PO-2. A topographic map was made of the floodplain by aerial photography and mapping procedures. The peak flows were manually routed through the floodplain by the "flows on flood fans" procedure developed for New Mexico. The alluvial fan is reasonably uniform in slope and has relatively short reaches. The average depths of flooding and areas of flooding obtained correlate with the limited historical data. A map of area flooded by frequency was provided to the economist. The economist developed the relationships of the area flooded in acres.

### Hydrologic Design

The principal spillway capacity of the floodwater retarding structure was calculated to meet the New Mexico State Engineer's criteria and the Soil Conservation Service requirements contained in SCS Engineering Memo - 27.

Minimum floodwater storage requirements were determined by the procedures outlined in the National Engineering Handbook, Section 4, Hydrology, Chapter 21. Class "c" emergency spillway and freeboard hydrographs were developed using procedures contained in the same reference. The principal spillway hydrograph, emergency spillway hydrograph, and freeboard hydrograph were routed through the structures by use of computer programs.

The evaluation of the top of embankments was determined by flood routing the freeboard hydrograph through the structure and spillways beginning at the level of the 100-year sediment pools. The selection of the proper design and proportionment for the height of dam, emergency spillway, principal spillway, and other related structures was based on the routings of the class "c" freeboard hydrograph.

### Water Budget Study

A water budget study was made on the sediment pool of the floodwater retarding structure. Oak Wash is an ephemeral stream and therefore does not have a base flow. Precipitation records from the Black Rock Station, U.S. Weather Bureau, were used to analyze the watershed yield. Average annual pan evaporation from Technical Report 31 was used to obtain the average annual lake evaporation. The seasonal reservoir evaporation from Figure 6, Technical Report 31, was used to develop monthly evaporation data. The analysis was by the direct runoff method. The period from October 1957 to September 1967 was used as the accounting period for the operations study. The analysis reveals that the average annual yield of inflow from the watershed is not adequate for permanent water in the sediment pool.

## SEDIMENTATION AND RELATED INVESTIGATIONS

Field investigations pertaining to erosion and sediment problems in the watershed were conducted in accordance with standard procedures of the Soil Conservation Service. Erosion on the uplands is slight to severe. The soil and range inventory map compiled by the Bureau of Indian Affairs together with field examination was used to determine the extent of erosion. The erosion rate was estimated using the measured sediment yield and the area method delivery ratio. Sediment yield to the proposed structure

was estimated using the measured rate of sedimentation of an earlier built reservoir that is now breached and located upstream from the proposed structure. Yields from the area below the present structure and from the present sediment pool were estimated. Sediment yield to the proposed structure is estimated at the rate of 43.5 acre-feet per year.

In the agricultural damage area, 19 holes were augered at selected locations. Soil profiles were mapped. With the aid of these profiles, air photos, and a topographic map, sediment deposition areas were mapped to indicate depth of modern deposits.

### G E O L O G I C   I N V E S T I G A T I O N

A preliminary investigation was made at the structure site in accordance with Soil Conservation Service Engineering Memo 33 (Rev.). The investigation included reconnaissance of all surface features and the use of a backhoe to determine subsurface conditions. Fifteen holes were put down across the area of the proposed center line. Twelve holes were excavated in potential borrow areas. Undisturbed samples of materials from the foundation and disturbed samples of materials in the borrow areas were collected. Laboratory tests were conducted on the samples to determine grain size analysis, soluble salts, atterburg limits, unit weight, and consolidation potential.

The site lies across a recent to modern alluvial fan. The material of this fan consists of clayey sand, sandy silt, and sandy clay (SC) and (CL). It is underlain by red sandstone and clay shale of the Chinle Formation of Triassic age.

A detailed site investigation, including field and laboratory testing and analysis of foundation and borrow materials, will be made prior to final design and construction.

### E C O N O M I C   I N V E S T I G A T I O N S

#### Determination of Damages and Damage Reduction Benefits

Damaging floods of 1924, 1958, 1965, and 1970 were briefly investigated. The completion of the Zuni Comprehensive Development Plan in 1969 and the vigorous implementation of the plan beginning in 1971 formed a basis for estimating "future" conditions. These "future" conditions are so different from "past" conditions that investigations of past floods would be useless, except for a few damages.



Reach A is the land in the Zuni Irrigation Unit. It was determined from the Bureau of Indian Affairs' records and interviews with farmers that most of Reach A was in hay and pasture until about 1938. The land has gone out of production since then because of damaging floods to crops and the delivery canal. It was determined through interviews with land operators, that without the project, this land will remain out of production. However, the idle land will be returned to production when adequate flood protection is provided.

Based on the Zuni Comprehensive Development Plan, studies presently being carried out by the Bureau of Indian Affairs and other activities, it is concluded that an adequate supply of irrigation water will be provided. However, only 1,500 acres of irrigated cropland have been included in the economic analysis, since adequate irrigation water is not presently available for a larger area.

Cost-return budgets for the various crops were used to estimate the per acre net income benefits resulting from more intensive land use. It is assumed that all of the benefits will be due to flood protection since irrigation water is available.

Non-agricultural damages in Reach A occur to the irrigation canal and canal road. The Bureau of Indian Affairs' records were used to estimate these damages on an average annual basis.

The Village limits for the Zuni Pueblo have been established by the limits of utility services. Residential and commercial building locations are approved by the Public Health Service Field Engineer. This area within the Village limits was designated Reach B.

Residential and commercial locations and improvements were located on a map at a meeting with the Zuni Housing Officer, Chairman of the Zuni Housing Authority, the Executive Director of the Zuni Housing Authority, and the Field Engineer of the Public Health Service for Zuni. The Zuni Administrative Officer provided information on an extensive improvement program for existing homes. Depths of flood flow through Reach B were placed on the map by the Hydrologist for different frequencies of floods.

Plans for the houses to be constructed were obtained from contractors. Damage estimates by depth or duration of flooding were obtained by contractors and repairmen. These estimated damages to homes are 74 percent of the damages obtained by using "Floodwater Damage Estimates, Residential and Commercial Property", Technical Service Center (TSC) Technical Note - Watershed - PO-4", dated June 1971.

Damage-frequency curves were used to obtain an average annual damage to future residential property, commercial buildings and contents, roads, and utilities. The average annual damages



to residences and commercial buildings and contents were increased by 2.08 based on increased value of future damageable property in Water Resource Subarea 1501.

#### Indirect Damages

The indirect damages were estimated to be 15 percent of the non-agricultural damage reduction and 10 percent of the agricultural damage reduction.

#### Secondary Benefits

The "stemming from" benefits were estimated at 10 percent of the direct benefits from more intensive land use and 10 percent of the direct benefits of non-agricultural floodwater damage reduction.

The "induced by" benefits were estimated at 10 percent of the annual project operation and maintenance cost and 10 percent of the increased agricultural production cost due to more intensive land use.

#### Redevelopment Benefits

The project is located within the Four Corners Regional Development Area. Redevelopment benefits are the sum of: (1) Thirty percent of the construction cost, for local labor, amortized over 100 years, plus; (2) 50 percent of the annual operation and maintenance cost for local labor calculated as a decreasing annuity over a 25-year period, amortized for a 100-year period.

### F I S H   A N D   W I L D L I F E   I N V E S T I G A T I O N S

Soil Conservation Service biologists made a field reconnaissance investigation of the watershed area on April 17-18, 1972. A report was prepared which described the types and conditions of existing wildlife habitats and made estimates of wildlife populations.

On October 1, 1973, a joint field investigation of the watershed area was made to consider the potential ecological impact of the proposed project. Participation included a member of the River Basins Staff, Regional Office, Fish and Wildlife Service; a staff member of the Gallup Office, Division of Wildlife Services, Fish and Wildlife Service; the Director of the Zuni Game and Fish Department; and the Soil Conservation Service State Biologist.

Following these field activities, a review was undertaken of biological reports supplied by the New Mexico Department of Game and Fish and the Bureau of Indian Affairs. Personal

communications were held with individual biologists of the Department of Game and Fish and the Biology Department at the University of New Mexico.

Analysis of information obtained by these investigations has indicated that wildlife of the watershed area are not abundant and that the anticipated improvements in watershed and range conditions will enhance wildlife habitats and populations.

### ARCHAEOLOGICAL AND HISTORICAL INVESTIGATIONS

A preliminary investigation was made by the University of Arizona and the National Park Service. The survey included the reconnaissance and investigation of about 1,100 acres for the proposed dam, outlet works, and the reservoir area up to the high water line. The investigation provided information on the location of places of archeological value or historical value. The Arizona State Museum has prepared a proposal for further archeological investigation and recovery of data from 18 sites identified. The additional investigation and salvage will be completed prior to start of construction for structural measures.

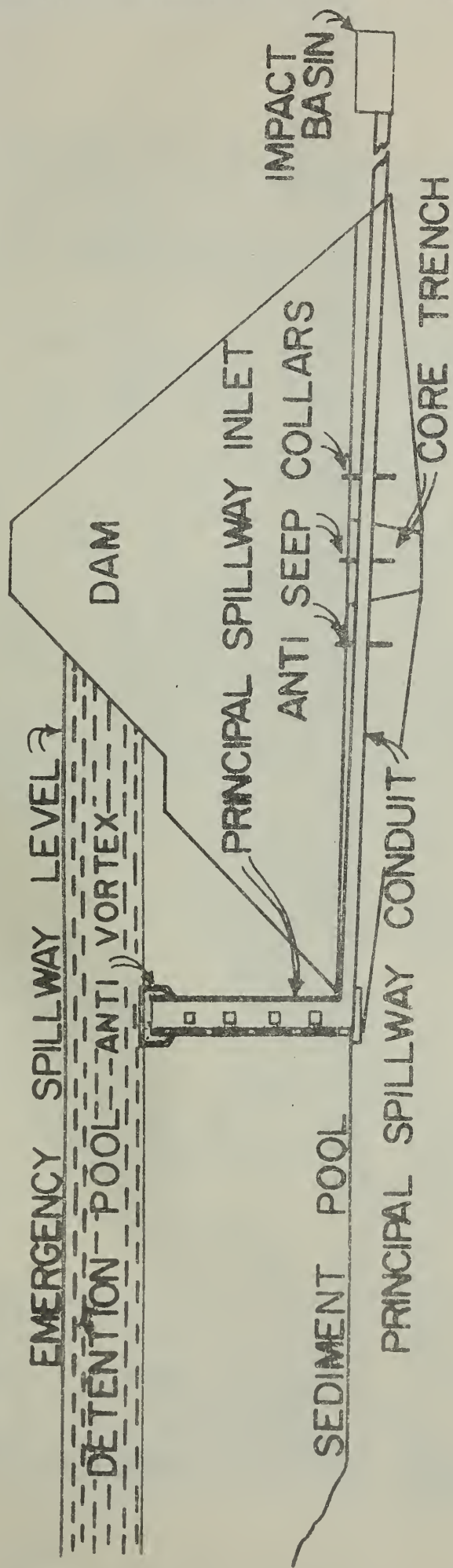
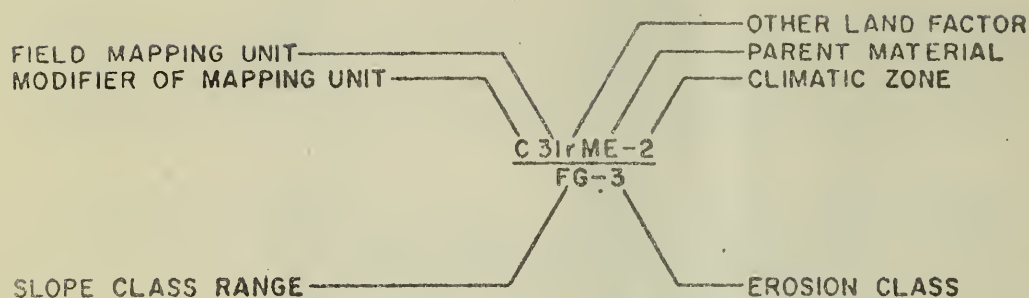


FIGURE 1

# SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



## SOIL SYMBOL



## FIELD MAPPING UNITS

	Deep Soils 36" Plus						Moderately Deep 20"-36"						Shallow Soils 10"-20"						Very Shallow Soils 5" - 10"	
	Permeability						Permeability						Permeability							
TEXTURE	VSP	SP	MP	RP	VRP		VSP	SP	MP	RP	VRP		VSP	SP	MP	RP	VRP			
FINE	1	2	3				13	14	15				25	26	27			36		
MEDIUM	4	5	6	7	7		16	17	18	19	19		28	29	30	31	31	37		
COURSE	8	9	10	11	12		20	21	22	23	24		32	33	34	35	35	38		
39 DEEP, ORGANIC SOILS												45 SOILS LESS THAN 5" THICK								
40 MODERATELY DEEP, ORGANIC SOILS												46 BADLANDS								
41 SHALLOW, ORGANIC SOILS												47 BARREN LANDS								
42 VERY SHALLOW, ORGANIC SOILS												48 ACTIVE SAND DUNES								
43 ROUGH, BROKEN OR STONY LAND												49 THIN BREAKS								
44 GULLIED LANDS												50 RIVERWASH								

## MODIFIERS OF PROFILE UNITS

- C Coarse Side of Medium Textures  
(Moderately Coarse Textures)
- M More-than-normal thickness of  
surface layers (>18")

## SLOPE CLASSES

- A 0-1% E 8-12%
- B 1-3% F 12-25%
- C 3-5% G 25-55%
- D 5-8% H 55% +

## OTHER LAND FACTORS

- b<sub>2</sub> FREQUENT OVERFLOW
- d GRAVELLY LAND
- r ROCK OUTCROP
- so SALINE-ALKALI CONDITION, UNDIFFERENTIATED
- so<sub>2</sub> SEVERE SALINE-ALKALI CONDITION
- w<sub>1</sub> SLIGHTLY WET LAND

## EROSION CLASSES

- 1 SLIGHT 4 GULLIED
- 2 MODERATE 5 SEVERELY GULLIED
- 3 SEVERE 6 SLIPS & LANDSLIDES
- 7 UNDIFFERENTIATED



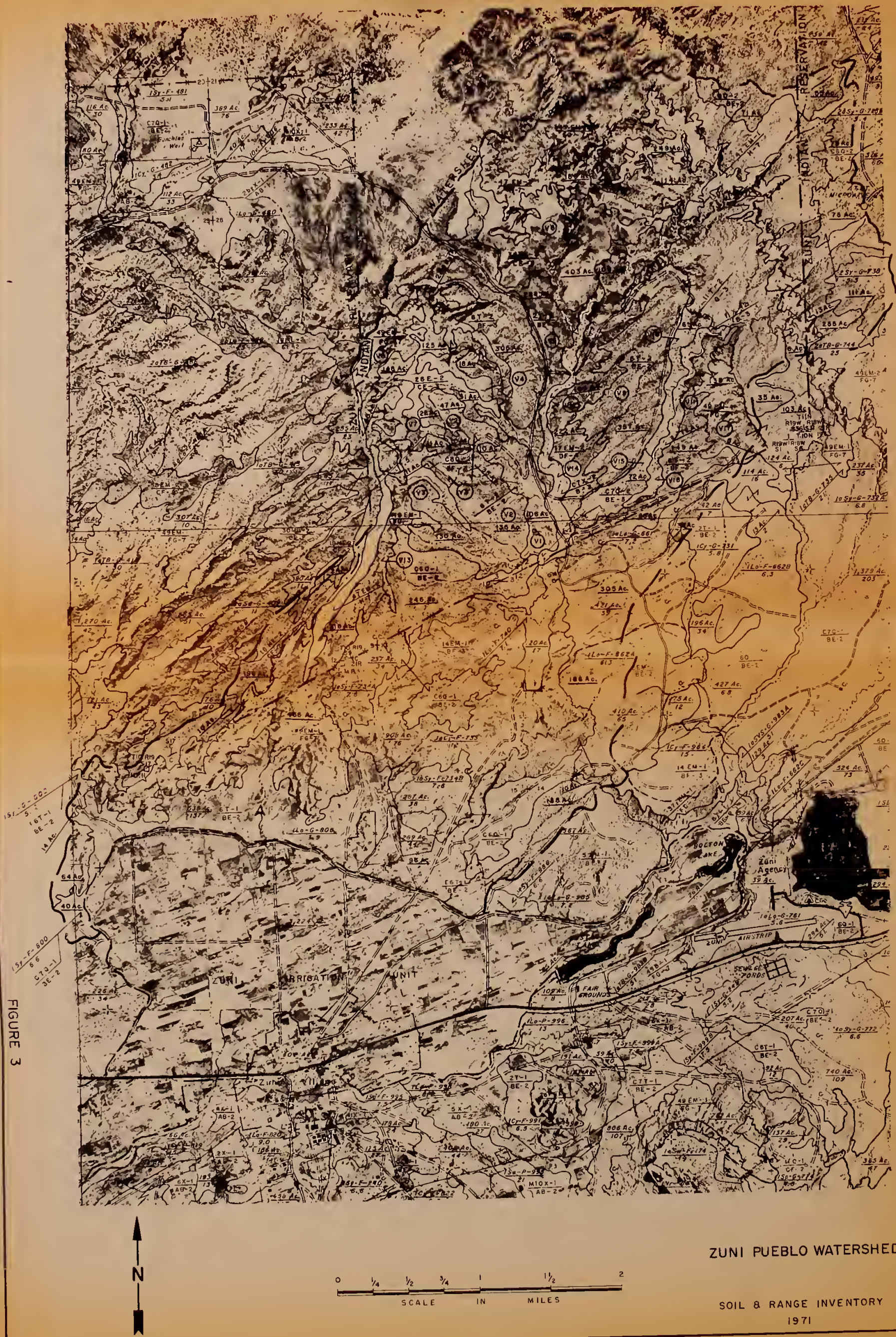
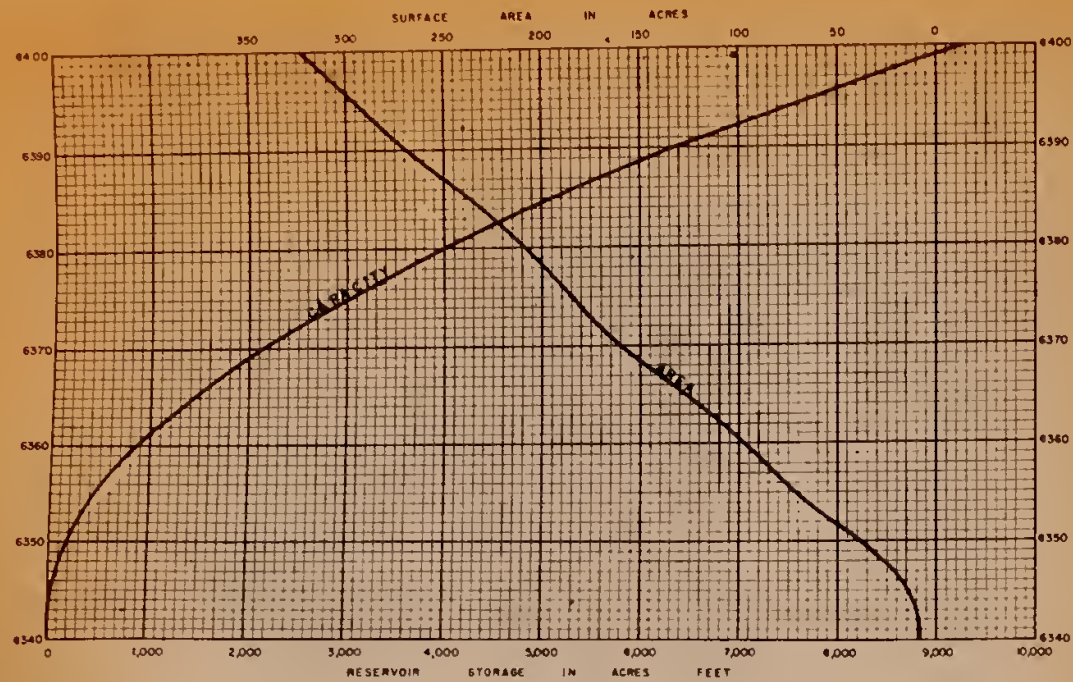


FIGURE 3

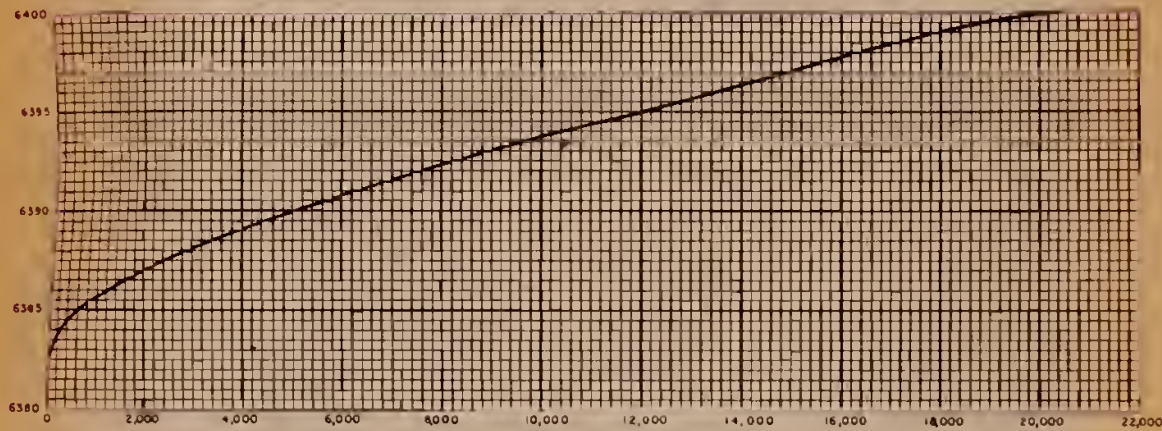




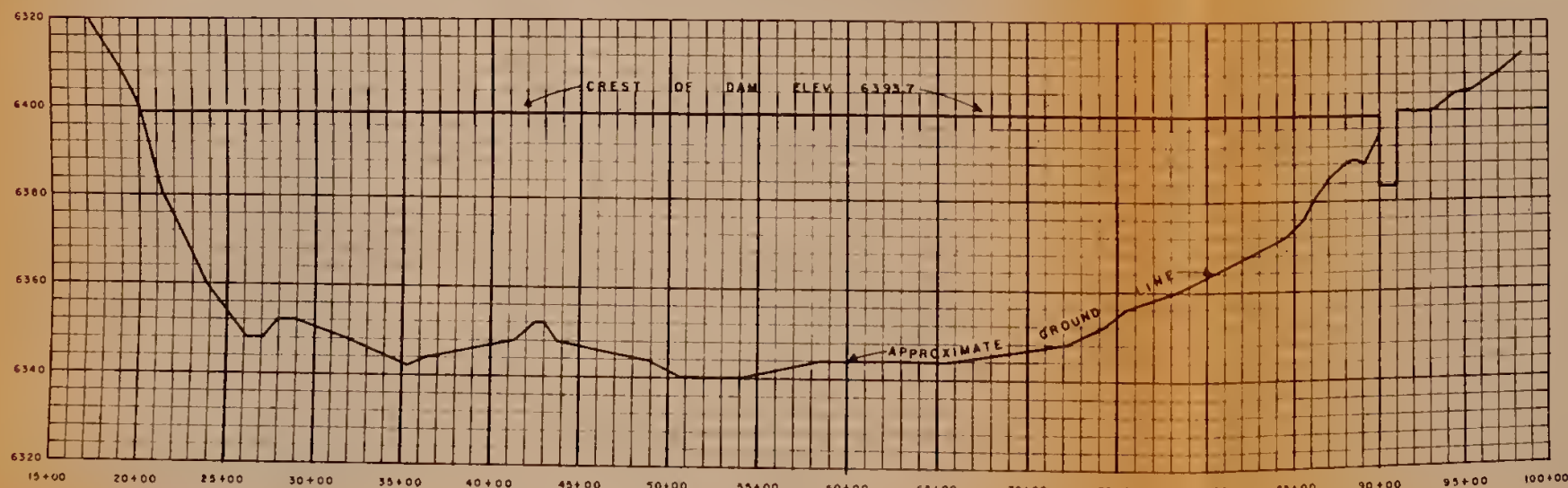




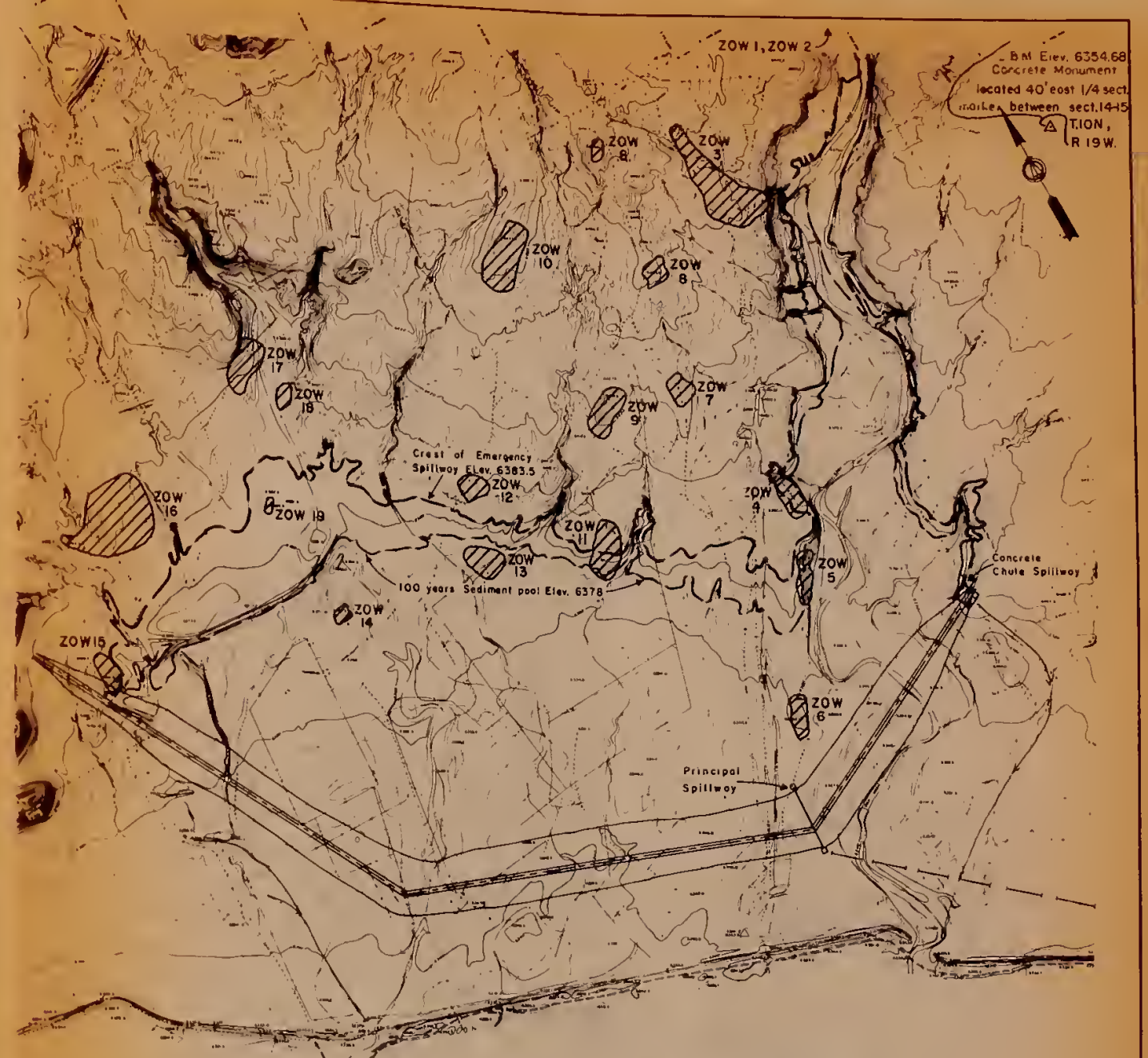
AREA - CAPACITY CURVE



STAGE - DISCHARGE CURVE - EMERGENCY SPILLWAY



PROFILE ON CENTER LINE OF DAM



PLAN OF DAM AND RESERVOIR

200 0 200 400 600 800 1000

SCALE IN FEET

ZOW 15 Located Archeological Resource

FLOODWATER RETARDING STRUCTURE  
ZUNI PUEBLO WATERSHED  
PLAN & PROFILE

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed by C. M. JACKSON	Date 7-72	Approved by	Title
Drawn SAMMY GARCIA	9-72		
Traced SAMMY GARCIA	9-72	Sheet	Drawing No.
Checked		No. 1	of 1

FIGURE 4







# LEDGEND

- FLOOD HAZARD BOUNDARY 100 YR. WITHOUT PROJECT
- - - WATERSHED BOUNDARY
- FLOOD HAZARD BOUNDARY 100 YR WITH PROJECT
- ▨ FLOODPLAIN COMMON TO OAK WASH & ZUNI RIVER
- IRRIGATION CANAL



## AGRICULTURAL AND URBAN FLOOD PLAIN

ZUNI PUEBLO WATERSHED  
McKINLEY COUNTY, NEW MEXICO

AUGUST 1972

3.3" = Miles

1" = 1600'

FIGURE 5

SCALE IN FEET





